BUREAU OF RECLAMATION

UNITED STATES DEPARTMENT OF THE INTERIOR

# OPERATING INSTRUCTIONS

## STRAWBERRY AQUEDUCT
## BONNEVILLE UNIT
## CENTRAL UTAH PROJECT, UTAH

APPROVED FOR OFFICIAL USE BY:

Regional Director

6/30/88
Date

UPPER COLORADO REGION

Salt Lake City, Utah

This filling schedule limits bore wave heights to 8 inches for sudden flow increase. Velocity of the bore wave varies from 9 to 20 ft/s as the preceding stages have increasing depths.

Since the bore wave velocity is two to three times the subsequent uniform velocity in these open flow reaches, with aggregate length of 108,600 feet, a much subdued bore wave will arrive at Currant Reservoir several hours ahead of its respective uniform flow. Also, since both bores waves and their increments of uniform flow travel faster in deeper water, successive bore waves can overtake the preceding bore waves(s) if the flow increases have not been adequately spaced. The combined mass with increased velocity will more than double the momentum, although with these small bore waves the result is acceptable.

## ITEMS OF SPECIAL IMPORTANCE

The facilities should be operated and maintained in accordance with this Operating Instructions. The following suggestions will be found helpful to avoid problems:

MINIMUM HIGH-PRESSURE GATE SETTING. To prevent damage to the gate leaf and frame, high-pressure regulating gates should not be operated for long periods of time at very small gate openings. A minimum gate opening of 0.1 foot is recommended.

OUTLET WORKS DROP INLET OPERATION. To prevent damage to the drop inlet by blowback through the shaft and conduit, restrictions should be placed on gate operations at low reservoir elevations.

REMOVAL OF ROCKS FROM CHUTES AND BASINS. Medium and large rocks do not wash out of stilling basins, even during large discharges. Instead they are picked up by the swirling water and pounded against the concrete walls and floor of the stilling basin. Signs should be posted prohibiting the throwing of rocks into the spillway and stilling basin.

TUNNELS. Before entering any tunnel or conduit for inspection and maintenance, satisfactory ventilation shall be provided, either by a mechanical ventilation system or by natural means obtained by opening air vents and/or doors at the tunnel portals or hatches at the top of shafts, and for conduits by opening manholes and other openings at the inlet and outlet structures. All diversions gates and in-line valves shall be closed and secured against accidental opening before entering the tunnel or conduit.

Underground operation of vehicles and equipment, using internal combustion engines burning gasoline or liquefied petroleum gases (propane, butane, propylene, or butylenes), is expressly forbidden. Diesel-powered vehicles and equipment used underground shall be approved and/or certified by MSHA (Mine Safety and Health Administration-formerly Bureau of Mines) and a permit shall be obtained from the State entity having jurisdiction before the equipment is taken underground. Ventilating requirements incident to such use also shall comply with MSHA recommendations. All vehicles and equipment shall be maintained in safe operating condition, ensuring compliance with the requirements stated above.

MAINTENANCE OF MINIMUM FLOWS. Special releases are to be made to maintain downstream fish habitat and some specific irrigation demands have been set. Refer to Chapter III, page 9 for details.

FILLING PROCEDURE, UPPER STILLWATER FLOW CONTROL STRUCTURE TO CURRANT CREEK RESERVOIR. The filling procedure found in Chapter III, Paragraph B, is very important to the safety and integrity of the Strawberry Aqueduct.

# PREFACE

This Operating Instructions has been prepared to establish, in one primary controlled document (with associated supporting documents), the complete, accurate, and current structure-oriented operating instructions. Their purpose is to ensure adherence to approved operating procedures over long periods of time and during changes in operating personnel. The instructions also will permit responsible persons, who are knowledgeable in aqueduct operation but are unfamiliar with the conditions at a particular aqueduct, to operate the system during emergency situations and at such times when the regular operator cannot perform his normal duties.

The Operating Instructions is prepared primarily for the use of operating personnel located at or nearest to the facilities and their immediate supervisors who are assigned the responsibility for the operation and maintenance of the system. THIS OPERATING INSTRUCTIONS CONTAINS, AS A MINIMUM ALL INFORMATION AND INSTRUCTIONS NECESSARY FOR THE OPERATORS TO PERFORM THEIR DUTIES. Operating procedures shall not deviate from those stated in the Operating Instructions without appropriate authorization and shall be reviewed and updated periodically by qualified regional office personnel.

The Designers' Operating Criteria (DOC) is prepared in the Office of the Assistant Commissioner, Engineering and Research Center, Denver, Colorado, and can be used to supplement the Operating Instructions. Frequent references will, therefore, be found throughout these procedures to the DOC which provide definite basic instructions for the safe, proper, and effective use of the facilities.

## VERIFICATION OF OPERATING INSTRUCTIONS BY RO&M TEAM

The RO&M team leader, either regional or E&R Center, shall sign and date an entry in the Operating Log to verify that:

(1) The current Operating Instructions is on hand and any revisions have been inserted.

(2) The Operating Log has been signed and dated by operating personnel and his supervisor to conform to Operating Instructions requirements.

(3) Operating procedures observed during the visit are in accordance with the Operating Instructions.

(4) Supporting documents pertinent to the operation of the system are available to the operator.

(5) Operating personnel have attended both classroom and onsite training.

(6) Recommendations to correct any Operating Instructions deficiencies will be made in the RO&M report.

All official members of the review team will sign the Operating Log as participating in the RO&M examination or other inspection of the facility.

## CERTIFICATION OF OPERATING INSRUCTIONS REVIEW BY OPERATOR

The purposes of this certification are to verify that the Operating Instructions is correct and current and that the operator and supervisor are familiar with its contents, use, and intent. The operating procedures, as presented in the Operating Instructions, are complete, accurate, and current or suggested changes will be furnished. The operator and supervisor understand that under normal communication conditions, no changes in operating procedures shall be made without the approval of the Regional Director and, if necessary, the E&R Center.

All operating personnel will certify to the above and sign the Operating Log.

Upon any changes in operating personnel, the new employee and supervisor shall follow the same procedures, beginning with a complete review of the Operating Instructions.

CONTENTS (continued)

OPERATING INSTRUCTIONS

FOR
STRAWBERRY AQUEDUCT

CONTENTS

OPERATING INSTRUCTIONS

This copy includes the following revisions:

| Revision No. | Date | Revision No. | Date |
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13-14

Central Utah Water Conservancy
District
355 West 1300 South
Orem, Utah 84058

Attachment

cc: Assistant Commissioner - E&R, Denver, CO
Attention: D-3300

Assistant Commissioner - Resources Management, Denver, CO
Attention: D-5210

Projects Manager, Provo, Utah
Attention: UPO-400

# United States Department of the Interior

BUREAU OF RECLAMATION
UPPER COLORADO REGIONAL OFFICE
P.O. BOX 11568
SALT LAKE CITY, UTAH 84147

IN REPLY
REFER TO: UC-435

Memorandum

To: Commissioner, Washington, DC
Attention: W-5120, 7456-MIB

From: Regional Director

Subject: Operating Instructions, Strawberry Aqueduct, Bonneville Unit, Central Utah Project, Utah (Operating Instructions)

Operating Instructions for the Strawberry Aqueduct have been completed and are hereby established as the official operating document for the system. Control copy number 1 is attached for your retention and use.

The following is the official distribution of the Operating Instructions:

| Copy Number | Location |
|---|---|
| 1 | Commissioner, Washington, DC<br>Attention: W-5120<br>Washington, DC |
| 2 | Assistant Commissioner -<br>E&R, Denver Office<br>Attention: D-3300<br>Denver, Colorado |
| 3-5 | Assistant Commissioner -<br>Resources Management<br>Attention: D-5210<br>Denver Office<br>Denver, Colorado |
| 6-10 | Regional Office<br>Attention: UC-400<br>Salt Lake City, Utah |
| 11-12 | Utah Projects Office<br>Attention: UPO-400<br>Provo, Utah |

# CHAPTER I
# GENERAL INFORMATION

## A. PURPOSE OF THE PROJECT

The Bonneville Unit is the largest and most complex of the authorized units of the Central Utah Project. Greater utilization of Bonneville Basin water, made possible by the unit plan and a transbasin diversion of water, will serve the needs of a growing population in the Bonneville Basin. This complex unit includes new reservoirs and the enlargement of existing reservoirs, more aqueducts, tunnels, and canals, powerplants, pumping plants, dikes, and drains.

### 1. THE STRAWBERRY COLLECTION SYSTEM

The Strawberry Collection System includes Upper Stillwater Dam and Reservoir, Currant Creek Reservoir, the enlarged Strawberry Reservoir, and the Strawberry Aqueduct with its various diversion structures and feeder pipelines. Upper Stillwater and Currant Creek Reservoirs are regulating impoundments along the Strawberry Aqueduct. The enlarged Strawberry Reservoir is located at the terminus of the aqueduct and provides storage for water destined for diversion to the Bonneville Basin.

The high elevations, cold temperatures, and mountainous terrain dictate the need for closed pipe and tunnel construction (28.7 miles of tunnel, 7.1 miles of siphon and pipeline, and 1 mile of open canal section). Water diversion and collection will take place virtually year round. The storage facilities at the three separate elevations will greatly lengthen out the seasons for adequate water flows for multi-uses. Maximum flows through the Strawberry Aqueduct are to be expected May through September.

Most features of the Strawberry Collection System are completed or under construction as here indicated.

#### a. UPPER STILLWATER DAM, RESERVOIR, AND COLLECTION WORKS

Upper Stillwater Reservoir has been constructed on national forest land approximately 43 miles northwest of the community of Duchesne, Utah. This reservoir will regulate flows of Rock Creek and the South Fork of Rock Creek for release to the Strawberry Aqueduct. The outlet works will bypass the fishery flows to Rock Creek and will have a capacity of 0 to 30 $ft^3/s$.

Upper Stillwater Dam will bypass the following irrigation and fishery flows as a first priority. Irrigation flows at 65 $ft^3/s$ in May and September, 110 $ft^3/s$ in June, 115 $ft^3/s$ in July, and 95 $ft^3/s$ in August must be bypassed by Upper Stillwater Reservoir to meet prior water rights downstream. These bypass flows do not change as they exceed all fishery bypass requirements under present consideration. Fishery bypasses for Upper Stillwater Reservoir are considered under three plans. The initial plan calls for a total 6,500 acre-foot bypass along the aqueduct and out of the enlarged Strawberry Reservoir. Of this 6,500 acre-foot bypass, Upper Stillwater Reservoir's bypass requirement will be 8 $ft^3/s$ for October through

April. Under another plan, the fishery bypass requirement for the aqueduct and enlarged reservoir will be 22,300 acre-feet. Upper Stillwater Reservoir's requirements, under this plan, increase April's bypass requirement to 15 $ft^3/s$ with no other changes to the reservoir's bypasses. Under the Instream Flow Agreement plan, the aqueduct and enlarged reservoir will be 44,400 acre-feet. Upper Stillwater Reservoir will bypass 23.5 $ft^3/s$ for October through March and 29 $ft^3/s$ in April under this plan.

Upper Stillwater Dam will then divert the flows of Rock Creek within the limit of the 285 $ft^3/s$ capacity to the Strawberry Aqueduct. Flows in excess of this will be stored in the Upper Stillwater Reservoir. The active capacity may fill and empty every year and the water surface could fluctuate approximately 140 feet from normal water surface elevation of 8,172.0 feet to a minimum water surface elevation of 8,028.4 feet. Under actual operation, Upper Stillwater Reservoir will be kept at its individual year's high content through out the summer (minus any extra irrigation bypasses) with reservoir content releases to the aqueduct beginning after October 1 until the reservoir empties its content. A separate Standing Operating Procedures draft has been prepared for the Upper Stillwater Dam.

b. CURRANT CREEK DAM AND RESERVOIR

Currant Creek Dam and Reservoir are located on Currant Creek in the Uinta National Forest, about 10 miles north of Strawberry Reservoir. Currant Creek Reservoir serves as a regulating facility and an open water connection along the Strawberry Aqueduct. It fluctuates only about 4 feet annually. The reservoir stores flows of Currant Creek and five of its smaller tributary streams and flows collected by the Strawberry Aqueduct above Currant Creek for release to the aqueduct below the reservoir. The canal's appropriate deliveries to the Strawberry Water Users Association are made through the Strawberry Aqueduct.

Reservoir water may also be diverted through the Strawberry Aqueduct which discharges into Strawberry Reservoir west of the Currant Creek drainage. Currant Creek Reservoir will have no irrigation bypass requirements. Under the Instream Flow Agreement plan, Currant Creek Reservoir will be required to bypass 9 $ft^3/s$ for October through March and 24 $ft^3/s$ for April through September for fishery bypasses. A separate Standing Operating Procedures draft has been prepared for Currant Creek Dam.

c. ENLARGED STRAWBERRY RESERVOIR

Soldier Creek Dam is located about 7 miles downstream from the original Strawberry Dam which was breached in June 1985. The new dam increases the capacity of the reservoir from 283,000 to 1,106,500 acre-feet. This reservoir is the primary storage facility for the Bonneville Unit, providing long-term storage of water for use in years of otherwise short supply.

The reservoir will reach maximum content during periods of high runoff and minimum content during periods of low inflow and high demand. Because of winter releases to other reservoirs in the Bonneville Basin, the yearly maximum content of Strawberry Reservoir may occur in March or April. Under a simulated reservoir operation, the reservoir would have emptied only once in the 40-year study period from 1921 to 1960. Enlarged Strawberry Reservoir will have some small irrigation bypasses (250 acre-feet per year) which will be eclipsed by the fishery bypass requirement for the reservoir. Under the 22,300 acre-foot and Instream Flow Agreement fishery bypass plans, Soldier Creek Dam will bypass 13 $ft^3/s$ for October through March and 26 $ft^3/s$ for April through September.

A separate Standing Operating Procedures draft has been prepared for Soldier Creek Dam.

## 2. STRAWBERRY AQUEDUCT

The Strawberry Aqueduct begins at Upper Stillwater Dam and Reservoir on Rock Creek, intercepts flows of nine tributaries of the Duchesne and Strawberry Rivers, and conveys these flows approximately 40 miles by gravity to the enlarged Strawberry Reservoir. In addition to Rock Creek, the aqueduct intercepts flows of the South Fork of Rock Creek, Hades Creek, Twin Creek, Wolf Creek, West Fork of the Duchesne River, Currant Creek, Layout Creek, and Water Hollow Creek. The enlarged Strawberry Reservoir will store this water for diversion to the Bonneville Basin. The enlarged reservoir will fill to elevation 7,602.4 (full active storage capacity). Elevation 7,577.22 was reached on May 29, 1987, leaving 25.2 feet of initial filling for future years.

In addition to the three reservoirs discussed above, various diversion structures and feeder pipelines which augment flows of the conveyance facility are located along the Strawberry Aqueduct. The aqueduct consists of tunnel, pipeline, and open-channel sections with size and capacity increasing as additional flows are diverted into it. The aqueduct begins with a tunnel 90 inches in diameter and a capacity of 285 $ft^3/s$ and terminates with an open-channel section with a capacity of 620 $ft^3/s$. The net divertable flow is defined as the total flow less the bypasses required for downstream prior rights and other uses. Downstream prior rights for the Duchesne River are computed as a flow requirement at the Duchesne River at the Hanna, Utah, gauge. These flow requirements are 40 $ft^3/s$ for October through March, 50 $ft^3/s$ for April and May, 110 $ft^3/s$ for June, 140 $ft^3/s$ for July, 100 $ft^3/s$ for August, and 80 $ft^3/s$ for September. If after the aqueduct has theoretically diverted stream flow, the flow requirements at Hanna, Utah, are not met then water is put back into the stream by these diversions: Hades, Win, Rhodes, and Vat. The listing is the order of priority until the flow requirements are met by the streams. At Vat Diversion, the West Fork of the Duchesne River will have fishery bypass requirements as described in the Table on page III-9. Other fishery bypass plans have no requirements on the West Fork of the Duchesne River.

Every effort will be made to load the Strawberry Aqueduct with the low elevation runoff first, as that divertable water cannot be stored. Water

is stored only at the Upper Stillwater and Currant Creek Reservoirs. This stored water will be released later as needed. The aqueduct consists of a reinforced-concrete intake structure; concrete-lined, circular tunnels totaling 29.5 miles in length; a welded-steel siphon with a length of 0.8 mile; five sections of precast concrete pipeline with a total length of 6 miles; and two open channels with a total length of 1 mile. The specific features of the aqueduct are discussed in the following sections, and related data are presented in the following tables.

Strawberry Aqueduct Diversion Structures

| Feature | Location | | Diversion capac. ($ft^3/s$) | Receiving conduit |
|---|---|---|---|---|
| | County | Stream | | |
| Docs Diversion Structure | Duchesne | South Fork Rock Creek | 100 | Docs Feeder Pipeline |
| Hades Creek Diversion Structure | Duchesne | Hades Creek | 30 | Hades Creek Feeder Pipeline |
| Win Diversion Structure | Duchesne | Twin Creek | 5 | Win Feeder Pipeline |
| Rhodes Diversion Structure | Wasatch | Wolf Creek | 30 | Rhodes Feeder Pipeline |
| Vat Diversion Dam* | Wasatch | West Fork Duchesne River | 300 | Vat Feeder Pipeline |
| Layout Creek Diversion Structure | Wasatch | Layout Creek | 20 | Layout Feeder Pipeline |
| Water Hollow Diversion Dam | Wasatch | Water Hollow Creek | 20 | Water Hollow Feeder Pipeline |

* Vat Diversion Dam will have a 40 acre-feet active storage capacity that will only be used to smooth out diurnal fluctuations. All other diversion structures operate without such a storage capacity.

Strawberry Aqueduct Conveyance Facilities

| Facility name and type | Cap. (cfs) | Length (mi.) | Location | |
|---|---|---|---|---|
| | | | Beginning at | Terminating at |
| Docs Feeder Pipeline | 100 | 0.8 | Docs Diversion Structure | Upper Stillwater Pipeline |
| Stillwater Pipeline | 285 | 0.2 | Upper Stillwater Dam outlet works | Stillwater Tunnel |
| Stillwater Tunnel | 285 | 8.1 | Stillwater Pipeline | North Fork Pipeline |
| North Fork Pipeline | 285 | 0.3 | Stillwater Tunnel | North Fork Siphon |
| North Fork Siphon | 305 | 0.8 | North Fork Pipeline | Hades Tunnel |
| Hades Creek Feeder Pipeline | 30 | 2.6 | Hades Creek Diversion Structure | North Fork Siphon |
| Hades Tunnel | 305 | 4.2 | North Fork Siphon | Wolf Creek Pipeline |
| Win Feeder Pipeline | 5 | 0.6 | Win Diversion Structure | Wolf Creek Pipeline |
| Rhodes Feeder Pipeline | 30 | 0.06 | Rhodes Diversion Structure | Wolf Creek Pipeline |
| Wolf Creek Pipeline | 305-325 | 7.04 | Hades Tunnel | Rhodes Tunnel |
| Rhodes Tunnel | 325 | 0.8 | Wolf Creek Pipeline | West Fork Pipeline |
| West Fork Pipeline | 325 | 4.2 | Rhodes Tunnel | Vat Tunnel |
| Vat Feeder Pipeline | 300 | 0.1 | Vat Diversion Dam | West Fork Pipeline |
| Vat Tunnel | 475 | 7.3 | West Fork Pipeline | Currant Creek Reservoir |
| Currant Creek Pipeline | 620 | 0.7 | Currant Creek Dam | Currant Tunnel |
| Currant Tunnel | 620 | 1.7 | Currant Creek Pipeline | Layout Siphon |
| Layout Siphon | 620 | 0.04 | Currant Tunnel | Layout Tunnel |
| Layout Creek Feeder Pipeline | 20 | 0.8 | Layout Creek Diversion Structure | Layout Siphon |
| Layout Tunnel | 620 | 3.3 | Layout Siphon | Water Hollow Siphon |
| Water Hollow Siphon | 620 | 0.05 | Layout Tunnel | Water Hollow Tunnel |
| Water Hollow Feeder Pipeline | 20 | 0.1 | Water Hollow Diversion Dam | Water Hollow Siphon |
| Water Hollow Tunnel | 620 | 4.1 | Water Hollow Siphon | Open Channel No. 2 |
| Open Channel No. 2 | 620 | 0.4 | Water Hollow Tunnel | Enlarged Strawberry Reservoir |

All aqueduct facilities upstream of Hades Tunnel are located in Duchesne County; Hades Tunnel is located in both Duchesne and Wasatch Counties; and all facilities downstream of Hades Tunnel are located in Wasatch County.

The Strawberry Aqueduct consists of three facility types-pipelines (including siphons), tunnels, and open channels.

a. DOCS DIVERSION STRUCTURE AND FEEDER PIPELINE

Docs Diversion Structure is located on the South Fork of Rock Creek and is a reinforced drop inlet to Docs Feeder Pipeline. The pipeline has a capacity of 100 $ft^3/s$ and will convey flows from the South Fork of Rock Creek to Upper Stillwater Pipeline.

b. UPPER STILLWATER PIPELINE

The Upper Stillwater Pipeline is located between the Upper Stillwater Dam Guard Gate Structure and the inlet portal of the Stillwater Tunnel. The pipeline is designed to carry flow from Upper Stillwater Reservoir to the Stillwater Tunnel and to Rock Creek downstream of the dam, or both. The pipeline consists of two sections, a 72-inch-diameter steel pipe section designed for pressure-flow conditions and a 90-inch diameter concrete pipe section for free-flow conditions. Total length of the pipeline is 0.2 mile. An ultrasonic flowmeter is housed in a structure along the pressurized portion of the line to measure flow from the reservoir to the pipeline control structure. A tee section along with approximately 140 feet of 54-inch-diameter steel pipe is provided to allow connection to Docs Feeder Pipeline.

The control structure is located at the downstream end of the pressurized section of the pipeline. The control structure houses flow rate control valves for the flow control to the Strawberry Aqueduct and serves to divert water to Rock Creek for low flow rates during drought years and high flow rates during emergency evacuation of the reservoir. The free flow portion of the pipeline ends at the inlet portal of Stillwater Tunnel. The portal structure serves to connect the pipe to the tunnel and to provide vehicular as well as personnel access to the tunnel.

c. STILLWATER TUNNEL

The 8.1-mile-long Stillwater Tunnel is the upper tunnel and beginning conveyance feature of the Strawberry Aqueduct. It begins at Upper Stillwater Reservoir and passes through the drainage divide separating Rock Creek from the North Fork of the Duchesne River. Reclamation has conducted an intensive research program in connection with the construction of this tunnel. The purpose of the program was to develop new and effective investigative methods and to refine equipment and procedures for tunnel excavation, support, and lining.

d. NORTH FORK PIPELINE

The North Fork Pipeline begins at the outlet of Stillwater Tunnel with 90-inch-diameter pipe designed for 285 $ft^3/s$ of free flow. From the outlet portal, the pipeline extends approximately 1,560 feet along the hillside to a point at which the siphone starts down the hillside. An 18-inch-diameter air vent is provided at this point to ventilate the transition from open to pressure flow.

e. NORTH FORK SIPHON

North Fork Siphon will have a capacity of 305 $ft^3/s$. This siphon will cross the North Fork of the Duchesne River about 4 miles upstream from the confluence of the West Fork and the North Fork. The siphon will extend from the North Fork Pipeline on the east slope of the North Fork Duchesne River Canyon across the canyon southwesterly to the inlet portal of Hades Tunnel on the west slope.

f. HADES CREEK DIVERSION STRUCTURE AND FEEDER PIPELINE

The Hades Creek Diversion Structure is located on Hades Creek, less than a mile upstream from its confluence with the North Fork of the Duchesne River. It will divert Hades Creek flows into the 30 $ft^3/s$ Hades Creek Feeder Pipeline, which will convey the water 2.6 miles to the North Fork Siphon of the Strawberry Aqueduct.

g. HADES TUNNEL AND WOLF CREEK PIPELINE

Hades Tunnel extends 4.2 miles from the North Fork of the Duchesne River to Wolf Creek. The completed Wolf Creek Pipeline has an increasing capacity ranging from 305 to 325 $ft^3/s$. It conveys water from the outlet portal of Hades Tunnel to the inlet portal of Rhodes Tunnel.

h. WIN DIVERSION STRUCTURE AND FEEDER PIPELINE

The Win Diversion Structure will divert water from Twin Creek into the Win Feeder Pipeline, which will have a capacity of 5 $ft^3/s$. The feeder pipeline will convey the water 0.6 mile to the Wolf Creek Pipeline of the Strawberry Aqueduct.

i. RHODES DIVERSION STRUCTURE AND FEEDER PIPELINE

The Rhodes Diversion Structure will divert flows from Wolf Creek to the 30 $ft^3/s$ Rhodes Feeder Pipeline, which will convey them 0.3 mile to Wolf Creek Pipeline of the Strawberry Aqueduct.

j. RHODES TUNNEL AND WEST FORK PIPELINE

The Rhodes Tunnel extends from the Wolf Creek Pipeline to the West Fork Pipeline. The West Fork Pipeline with a capacity of 325 $ft^3/s$. This pipeline conveys water from the Rhodes Tunnel along the north side of the West Fork of the Duchesne River Canyon to the inlet portal of Vat Tunnel.

k. VAT DIVERSION STRUCTURE AND FEEDER PIPELINE

The Vat Diversion Structure diverts flows of the West Fork of the Duchesne River into the Vat Feeder Pipeline. The structure includes a 50-foot-long overflow weir, and earth dam, a headworks for two intake pipes, and a sluiceway which is also used as a river outlet. The 300-$ft^3/s$ Vat Feeder Pipeline conveys the water to the West Fork Pipeline of the Strawberry Aqueduct, slightly above the inlet portal of Vat Tunnel.

l. VAT TUNNEL

The 7.3-mile-long Vat Tunnel conveys the Strawberry Aqueduct water form the West Fork Pipeline through Red Creek Mountain to a short open channel (Open Channel No. 1) for delivery to Currant Creek Reservoir.

m. CURRANT CREEK PIPELINE

Currant Creek Pipeline, with a capacity of 620 $ft^3/s$, conveys water from the outlet works of Currant Creek Reservoir, southeast along the west side of Currant Creek Canyon to Currant Tunnel.

n. CURRANT TUNNEL

The concrete-lined Currant Tunnel conveys water 1.7 miles from Currant Creek Pipeline to the Layout Tunnel of the Strawberry Aqueduct at Layout Creek.

o. LAYOUT CREEK DIVERSION STRUCTURE AND FEEDER PIPELINE

Layout Creek Diversion Structure and Feeder Pipeline are located about 2 miles up the steep-sided and narrow Layout Canyon from the confluence of Layout Creek and Currant Creek. The diversion structure consists of a reinforced concrete drop inlet structure which bifurcates the intake flow, with up to 20 $ft^3/s$ going to the feeder line and the remainder to the sluice pipe. The Layout Creek Feeder Pipeline extends from the Layout Creek Diversion Structure to the Strawberry Aqueduct, joining it at the outlet portal access structure of Currant Tunnel.

p. LAYOUT TUNNEL

The concrete-lined Layout Tunnel conveys water from Currant Tunnel 3.3 miles through a high ridge to the start of Water Hollow Tunnel at Water Hollow.

q. WATER HOLLOW DIVERSION STRUCTURE AND FEEDER PIPELINE

Water Hollow Diversion Structure and Feeder Pipeline are located in Water Hollow about 4.5 miles upstream from its confluence with Currant Creek. The diversion structure is a reinforced concrete structure with protective dikes extending from the diversion dam to each side of the hollow. The headworks are controlled by slide gates regulating discharge into the 10-$ft^3/s$ Feeder Pipeline, which extends from the diversion dam to the Strawberry Tunnel.

r. WATER HOLLOW TUNNEL

The 4.1 mile-long Water Hollow Tunnel begins at Water Hollow and conveys project water from the Layout Tunnel to Open Channel No. 2.

s. OPEN CHANNEL NO. 2

Channel No. 2 is an earth-lined open-channel section with several concrete drop structures. It conveys water about 0.4 mile from the outlet portal of the Water Hollow Tunnel to the enlarged Strawberry Reservoir. It is the terminal feature of the Strawberry Aqueduct. (Open Channel No. 1 is the very short channel mentioned above which conveys water from Vat Tunnel to Currant Creek Reservoir.)

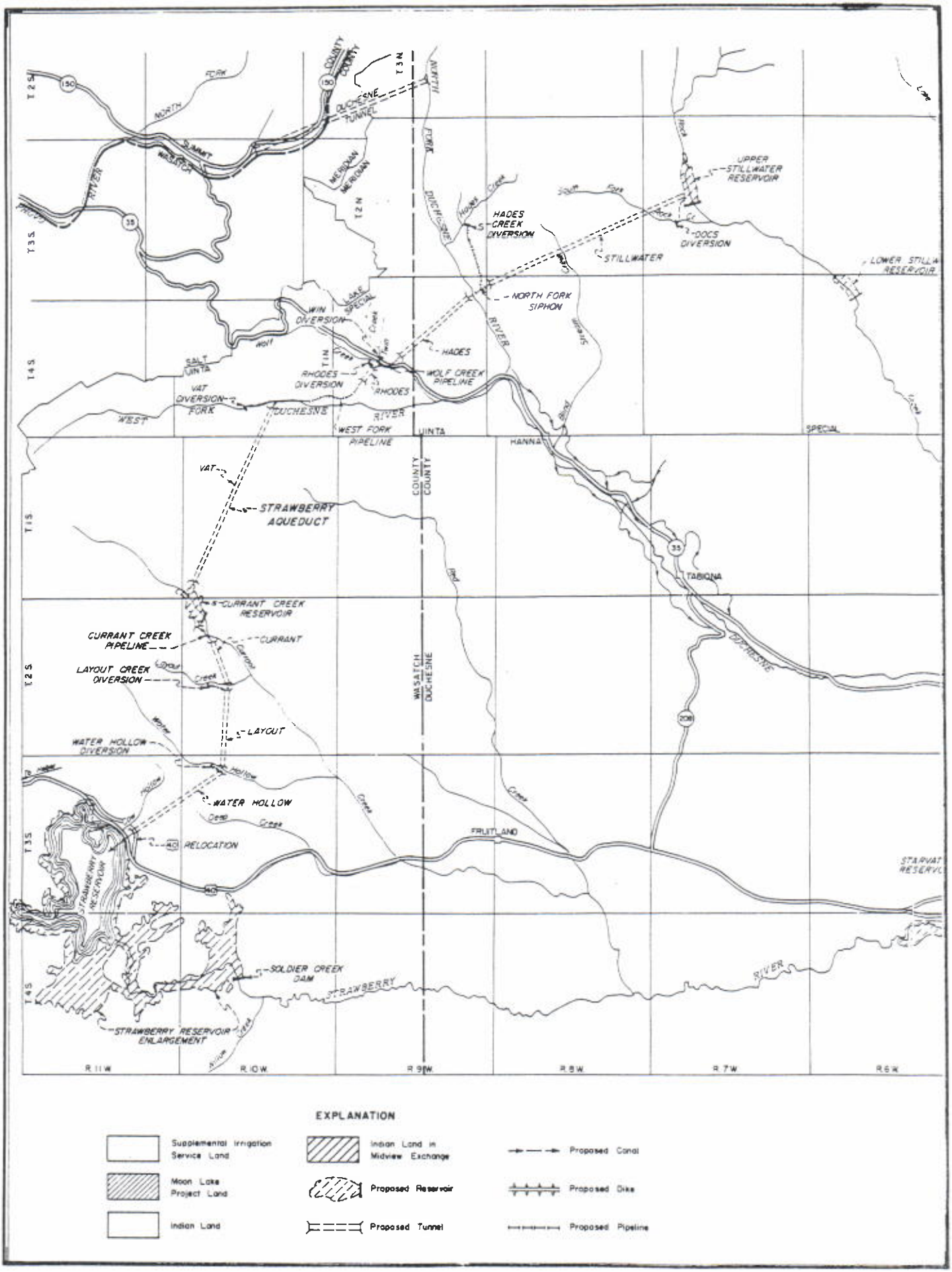
## B. DIRECTIONS AND ACCESS TO THE STRAWBERRY AQUEDUCT

U.S. Highway No. 40 is a well-traveled asphalt highway open for year round use. Once you leave the paved asphalt road you travel on a well-graded gravel road with good access during the summer months.

No roads or trails are located along the Strawberry Aqueduct. However, short trails from existing mountain highways provide access to the tunnel portals and to the conduits and siphons. These trails connect with the existing paved U.S. Highway 40 and Utah Highway 134 and with the partially paved or graded Utah Highway 35.

Access during inclement weather may be restricted to four wheel drive vehicles. With the accumulation of winter snow and blizzard conditions, travel may be limited to snowmobiles and snowcats.

The nearest commercial airports are located in Provo and Vernal, Utah. Small airports are located in nearby Heber City and Duchesne, Utah.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HADES CREEK DIVERSION
DOCS DIVERSION
STILLWATER
LOWER STILLWATER RESERVOIR
NORTH FORK SIPHON
WIN DIVERSION
HADES
RHODES DIVERSION
RHODES
WOLF CREEK PIPELINE
VAT DIVERSION
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COUNTY
EXPLANATION
Supplemental Irrigation Service Land
Moon Lake Project Land
Indian Land
Indian Land in Midview Exchange
Proposed Reservoir
Proposed Tunnel
Proposed Canal
Proposed Dike
Proposed Pipeline

## C. ASSIGNMENT OF RESPONSIBILITY

The Central Utah Water Conservancy District has the responsibility for the care, operation, and maintenance of the Strawberry Aqueduct as construction is completed.

Responsibility for review of maintenance and safety aspects of the system will be a continuing responsibility of the Bureau of Reclamation. The Utah Projects Office, Provo, Utah, will directly represent the interests of the United States in these matters.

The Engineering and Research (E&R) Center provides technical support service for operation of Reclamation projects. In this regard, the E&R Center prepares Designers' Operating Criteria (DOC), furnishes guidelines for the preparation of and reviews Standing Operating Procedures (SOP), and approves certain operating procedures.

The E&R Center also periodically examines all major structures under the Review of Maintenance Program and as required recommends corrective measures, makes safety studies, recommends corrective actions under the Examination of Existing Structures Program, reviews behavior data, and supplies technical advice and assistance in the solution of operating and maintenance problems.

Personnel responsible for the operation, maintenance, and safety of the Strawberry Aqueduct as described above are: Central Utah Water Conservancy District, Utah Projects Office, and Regional office.

Modifications of the dams and related structures and appurtenances cannot be accomplished without the concurrence of the Regional Director and the E&R Center.

## D. ATTENDANCE, COMMUNICATIONS AND WARNING SYSTEMS

The Central Utah Water Conservancy District is identified with the operations of the Strawberry Aqueduct. Their office is located at 355 West 1300 South, Orem, Utah 84057.

There is no one stationed along the Strawberry Aqueduct full time. The nearest telephones are located at Strawberry Office on U.S. Highway 40, Currant Creek Junction on U.S. Highway 40, Currant Creek Field Station at Currant Creek Dam, the Pipeline Control Structure at Upper Stillwater Dam, and the Duchesne Construction Office in Duchesne.

## E. COOPERATION WITH OTHER AGENCIES

1. The Central Utah Water Conservancy District will assume the operation and maintenance responsibilities under the terms of the December 29, 1987, "Cooperative Agreement Between the United States of America and the CUWCD." This transfer of responsibility for the rest of the Strawberry Aqueduct will take place upon the successful completion of the initial filling of Upper Stillwater Reservoir.

2. The United States Forest Service will administer the recreational facilities under a memorandum of agreement with the Bureau of Reclamation.

3. The Utah Division of Fish and Game stocks the reservoir and enforces all laws and regulations regarding hunting and fishing in the area.

4. Bureau of Reclamation administration of the Strawberry Aqueduct is under the direction of the Utah Projects Office, Provo, Utah. Reclamation has a basic interest in the structures and continuing responsibility for ascertaining that unauthorized encroachments do not occur, that existing or potential conditions do not lead to public criticism or to injury to the public, and that nothing is done which conflicts with the primary purpose of the project.

5. The Bureau of Reclamation and the Central Utah Water Conservancy District are parties to the Instream Flow Agreement executed February 27, 1980. Other involved parties are the U.S. Forest Service, U.S. Fish and Wildlife Service, and several State of Utah agencies. Specific minimum releases to maintain downstream fish habitat were established. The releases are specified in Chapter III, Section F, Fish and Wildlife Considerations.

## F. DATA REPORTING

The operator will take readings of diversions and bypass flows daily or as required to meet the State Engineer's instructions.

An accounting of all O&M costs and work will be provided, as required for inspection, by the District and submitted to the Utah Projects Office annually. This will provide base data for the annual O&M cost report to the Commissioner.

Personnel from the Utah Projects Office will assist in the collection of technical data as required. Data may include:

1. Tunnel closure point measurements,
2. Crack width gauge readings,
3. Settlement and Alignment Surveys,
4. Cathodic protection monitoring.

## G. OPERATING LOG

A logged record shall be maintained by either the operating personnel or the designated alternate on duty. The log shall be maintained in a bound book. The information shall include:

Typical Operating Log Entries

1. Normal and emergency modes of operation of outlet works and/or spillways including individual gate position changes of the diversion dams.

2. Flows and bypasses.

3. Startup and stopping of mechanical equipment.

4. Test of standby equipment for gate control.

5. Test and exercise of control devices (gates and valves).

6. Minor and major maintenance activities including scheduled maintenance.

7. Surveillance.

8. Initial acknowledgement of emergency or unusual conditions.

9. Acts of vandalism.

10. Request and concurrence to change from normal operation during emergency or unusual conditions.

11. Communications network checks.

12. Certification of Operating Instructions review by operating personnel and supervisor.

13. Verification of RO&M examination.

14. Miscellaneous items pertinent to operation, emergency, or unusual conditions at the structures.

All entries in the bound Operating Log shall be made legibly in ink, dated, and signed. Neither erasures nor ink eradicators shall be used to make corrections. Instead, an error should be crossed out lightly so that the incorrect notation is still legible after the correct entry is made. The log shall contain a chronological record of all important events to provide a continuing record of operating activities for future reference. This will be helpful to provide clues to the cause of equipment trouble or development of unusual conditions occurring at structures.

## H. PUBLIC SAFETY AND HEALTH

Since safety is of primary concern, and the Strawberry Aqueduct is not attended full time, operating personnel are to note unsafe conditions or acts and to report them to authorities for correction. Public use at or near the facilities is great for fishermen, hunters, campers, etc. Remoteness of the facility from medical or law enforcement assistance is noted. No safety equipment is available at the facility; i.e., first-aid kits, fire extinguishers, ladders, etc.

A list of law enforcement, medical aid, and fire protection agencies follow. See the Communications Directory for phone numbers as contained in the Standing Operating Procedure book at Upper Stillwater, Currant Creek, or Soldier Creek Dams.

### Fire Protection

Altamont
Heber City
Duchesne
Tabiona
Fruitland

### Police Protection

Wasatch County Sheriff's Office
Duchesne County Sheriff's Office
U.S. Park Police in Washington DC

### Medical

Heber Valley Care Center
Heber Valley Clinic
Medical Clinic of Duchesne

### Ambulance Service

Altamont
Wasatch County Emergencies
Ute Tribe Ambulance
Tabiona
Duchesne
Life Flight
Air Med

### Hospitals

Wasatch County Hospital
Duchesne County Hospital

It will be the responsibility of the Central Utah Water Conservancy District to assure that personnel working on or operating the facilities will do so in accordance with applicable State and Federal Safety Regulations.

## 1. ACCIDENT REPORTING

Accidents involving death, serious personal injury, or substantial property damage at the Strawberry Aqueduct must be immediately reported to the regional office, Salt Lake City, Utah, through the Utah Projects Office, Provo, Utah.

The regional office will make all necessary telegraphic reports to the Commissioner and to the E&R Center, Attention D-160 and D-400, and will aid in the accident investigation and preparation of Form DI-134 where required.

Any incident which may result in a Tort or Appropriation Act (Irrigation) Claim, other than accidents normally reported to the Safety Officer, should be reported to the Regional Claims Officer.

## 2. POTENTIAL HAZARDS

It is anticipated an increase in the public use of this land area will occur. Most recreation pressure will be at the designated public facilities.

The aqueduct and appurtenant structures present an attractive danger for one who is inclined to explore or probe around. The thrillseeker, the curious, the showoff, and even the naive could venture into danger. The spillway chutes, drop structures, diversion dams, and tunnel portals could be treacherous due to water, algae, or ice. The outlet works and the spillway stilling basins are deep, steep, and unyielding.

Remoteness of this facility from medical or law enforcement assistance is something to reckon with. First-aid kits, fire extinguishers, boats, or other rescue equipment is not available along the aqueduct. Warning signs and fences are employed, but surveillance on the part of the operator is important.

The U.S. Forest Service will make and enforce such rules and regulations for the use of the area as are necessary and desirable to protect the health and safety of persons who visit. The Utah State Division of Fish and Game stock the streams and enforce all laws and regulations pertaining to fish and game.

## I. RESTRICTED AREAS

The Bureau of Reclamation has primary jurisdiction over all areas within or surrounding the aqueduct from which unauthorized persons are restricted. Signs are installed to keep out unauthorized persons. Restricted areas are those which are potentially hazardous to--or subject to damage by--the public.

Public entry into chutes, stilling basins, and control houses is restricted by barrier fences. Public access is limited from areas surrounding hydraulic structures intakes and reaches of outlet channel adjacent to discharge structures subject to surging or rapid changes in water surface elevation during releases. Signs warning of danger and signs prohibiting the throwing of rocks into the hydraulic chute and stilling basins are posted adjacent to the structures. The operator shall be responsible for adequate restrictive posting of all areas within the district's primary jurisdiction which are hazardous to the public.

## J. CIVIL DEFENSE AND SABOTAGE SECURITY PLANS

### 1. PLAN FOR PROTECTION OF FACILITIES

a. The security plan should be reviewed and revised annually. Times change and programs which functioned in the past are not necessarily adaptable to the present or future.

b. Prior planning and executing minimal strategic preparations will allow use of valuable time during an emergency, particularly on preparations that cannot be accomplished efficiently after an emergency arises. Phone numbers of the immediate supervisor and local law enforcement agencies or units shall be posted at all times.

c. Civil disturbances are sporadic in nature and are not necessarily restricted to urban areas. A remote facility could be a target for a demonstration.

d. Establish a communication link, with the local law enforcement unit and other governmental agencies, through which an alert can be received for suspected demonstrations or bomb threat and for the required anticipated assistance. Keep all doors, gates, and secured areas locked whenever possible except in cases where normal operation and maintenance would be impeded during the day shift. At the end of the workday, all main gates and local areas should be locked.

### 2. USE OF FIREARMS BY RECLAMATION PERSONNEL

In keeping with Reclamation guidelines (Reclamation Instructions 367.2.7) regarding carrying and use of firearms, Reclamation employees--including those employed as guards--may not carry firearms on their person in the performance of their duties unless authorized to do so by law.

This prohibition does not apply to small-bore rifles or shotguns which are carried in vehicles by operating personnel when required for the purpose of rodent control.

## K. OPERATING INSTRUCTIONS DISTRIBUTION

| Location | Number of Operating Instructions Copies |
|---|---|
| Office at Duchesne | 1 |
| Central Utah Water Conservancy District Office | 1 |
| Utah Projects Office | 2 |
| Upper Colorado Regional Office | 5 |
| Engineering and Research Center | 4 |
| Commissioner's Office | 1 |

All Operating Instructions copies are to be kept current. For this reason, a limited number are published as required for official distribution plus several to be retained in the regional office for replacement and other unforeseen uses. All copies are numbered for control.

## L. OPERATING INSTRUCTIONS REVISIONS

Revisions are the responsibility of the regional office. At least once each year, the Operating Instructions should be reviewed by operating personnel, project offices, and the regional office to ensure that instructions are adequate and current. Revisions or deviations in operating instructions should be ascertained and either integrated into the Operating Instructions or deleted, as appropriate.

Operating procedures shall not deviate from those stated in the Operating Instructions and Supporting Documents without appropriate authorization. Changes are made only with the approval of the Regional Director.

Procedures and corresponding instructions that are based on:

Directives from the E&R Center
Concepts (O&M) visualized during design and construction
Hydrology
Other data or analyses for which an office at the E&R Center has reviewing responsibility

shall not be revised without referral--through the Regional Director--to the Chief, Division of Water and Land Technical Services, E&R Center, for concurrence prior to implementation of the revision. Where the need for deviation or revision develops during emergencies or critical operating conditions, concurrence should be obtained from the appropriate authorities by using the most expeditious means of communication; i.e., phone, radio, and faxogram.

Each revised page should show the revision number and revision date. Each Revision Sheet should be filed at the beginning of each Operating Instructions copy to indicate currentness.

The revision Letter of Transmittal shall be signed by the Regional Director or authorized alternate to indicate official approval of the changes. A Revision Sheet should accompany the letter and a revision date shall be noted at the bottom of each revised page in the lower right corner.

## M. SUPPORTING DOCUMENTS

Designers' Operating Criteria

## N. REFERENCE MATERIAL

### Bureau Specifications

DC-7421 - Hades and Rhodes Tunnels and Appurtenant Structures (includes Wolf Creek Siphon)

DC-7361 - Vat Diversion Dam and West Fork Pipeline (Includes Vat Feeder Pipeline)

DC-7150 - Vat Tunnel

DC-6855 - Strawberry Aqueduct - Currant and Layout Tunnels, Diversions, and appurtenant Structures (Includes Water Hollow Diversion Dam and Feeder Pipeline, Layout Stream Inlet and Feeder Pipeline, Layout Siphon, and Water Hollow Siphon)

DC-6575 - Strawberry Aqueduct - Water Hollow Tunnel and Channel No. 2

DC-7038 - Currant Creek Dam (Includes Currant Creek Pipeline and its appurtenant structures)

DC-7596 - North Fork Siphon

DC-7246 - Strawberry Aqueduct Stillwater Tunnel

DC-7676 - Docs Feeder Pipeline

DC-7683 - Rhodes and Win Diversions and Pipelines

### Bureau Publications

Earth Manual, Second Edition - reprinted 1980

Power Systems Safety Handbook - Specialists Supplement No. 1

Paint Manual, Third Edition, 1976

Concrete Manual, Eighth Edition, revised 1981

Water Measurement Manual, Second Edition, revised reprint 1984

# CHAPTER II

# ELECTRICAL, MECHANICAL, AND STRUCTURAL

## A. GENERAL DESCRIPTION OF FACILITIES

Within this chapter discussions are made on the description and scope of the criteria, location and description, and the general plan of operations of the features.

The structures and features within this chapter are discussed in sequential order from upstream to downstream as they occur in the aqueduct system. Specific and detailed information on the function, hydraulics, appurtenant features, and operation and maintenance requirements is presented, as applicable.

The purpose of this Operating Instructions is to provide O&M (operation and maintenance) personnel with a detailed working knowledge of the operational scheme of the features of the Strawberry Aqueduct water delivery system and to outline the basic operation and maintenance requirements for each installation.

All responsible operating personnel should be thoroughly checked out on the operations of the facilities, including standby methods of operations, and should be indoctrinated on the importance of following the prescribed operational methods and procedures. Operating personnel should familiarize themselves with the details to gain a better understanding of all requisites for attaining maximum safety and efficiency in operation.

It is expected that experience gained after a period of trial operation will enable operation and maintenance supervisory personnel to amplify and supplement these criteria by means of instructions posted in the structures which house the operating equipment. Manufacturers' instructions and criteria should be included and used in conjunction with these criteria.

The Strawberry Aqueduct collection system is designed as a combination free-flow and pressure-flow system. The water delivered to the Enlarged Strawberry Reservoir is to be used for both irrigation and M&I purposes.

### 1. UPPER STILLWATER RESERVOIR

The principal function of Upper Stillwater Dam is to divert a flow of water up to 285 $ft^3/s$ into the Strawberry Aqueduct. In addition, the river outlet works will provide discharges up to 29 $ft^3/s$ to maintain minimum streamflows in Rock Creek. Both diversions are withdrawn through a single vertical intake tower, carried through a 72-inch-diameter Upper Stillwater Pipeline (USP) passing underneath the dam, and then separating at the Guard Gate Structure (GGS).

This structure houses one manual butterfly valve, one controller-operated butterfly valve, one ultrasonic flowmeter and equipment to transmit the flow signal to the Upper Stillwater Pipeline Control Structure (PCS).

Upon entering the Guard Gate Structure, the 16-inch-diameter River Outlet Works Pipeline (ROWP) separates from the Upper Stillwater Pipeline. Just past the bifurcation are a 16-inch butterfly guard valve on the ROWP, and a 72-inch motor-operated butterfly guard valve (72BF) on the USP. Valve 72BF can be operated by local pushbutton control from either the Guard Gate Structure, the Pipeline Control Structure, or manually should no power be available. The 16-inch butterfly valve must be closed manually.

A 16-inch ultrasonic flowmeter (16UF) measures the flow in the 16-inch River Outlet Works Pipeline. Flows from 0 to 29 $ft^3/s$ will be measured by 16UF. The flow signal will be transmitted to the Pipeline Control Structure where the flow rate will be indicated, recorded, and totalized on registering instruments.

## 2. UPPER STILLWATER PIPELINE

The 72-inch-diameter pipeline connects the Upper Stillwater Dam, Docs Feeder Pipeline, and the Upper Stillwater Pipeline Control Structure. The latter structure contains the regulating valves for the Upper Stillwater pipeline, the overflow and drought release bypass, the automatic control systems, and the telemetry system for the supervisory controls.

Just upstream of the Pipeline Control Structure, located on the Upper Stillwater Pipeline, is the Flow Measuring Structure containing a 72-inch ultrasonic flowmeter. The flowmeter (72UF) measures flows in the USP. The flow signal will be transmitted to the PCS, where the flow will be indicated, recorded, and totalized on registering instruments.

Upon entering the Pipeline Control Structure, the 72-inch Upper Stillwater Pipeline bifurcates into two 54-inch-diameter pipes. On each 54-inch pipe is located a 54-inch motor-operated butterfly guard valve, followed by a 54-inch regulating sleeve valve. The two 54-inch butterfly valves are to be used for isolating the sleeve valves for maintenance and/or operational problems. These butterfly valves will be operated from the Pipeline Control Structure with local pushbutton control only, or should power be lost, manually.

From the control structure, downstream to the Upper Stillwater Tunnel, the pipeline has a 90-inch inside diameter, to accommodate the design Q of 285 $ft^3/s$. Releases to Stillwater Tunnel can be made when the reservoir level is above elevation 8,028.4. Above this elevation, flow control of the tunnel is accomplished by local automatic operation of the two 54-inch motor-operated sleeve valves (54SV1 and 54SV2) in combination with the flowmeter 72UF. Any desired flow, to a maximum of 285 $ft^3/s$, is set on the flow controller locally at the Pipeline Control Structure. Once a flow setting is input, the two sleeve valves using flowmeter 72UF modulate until the flow setting is achieved. Below elevation 8,043.0, however, hydraulic losses in the USP limit the maximum releases that can be made to less than 285 $ft3/s$. The maximum releases gradually decrease until at elevation 8,028.4, the control sill in the PCS, no more water can be discharged into Stillwater Tunnel. Manual control of either of the two sleeve valves is also possible by use of a pushbutton control located on the controller.

Water exiting from each of the 54-inch sleeve valves flows under separate orfice plates into the 90-inch-diameter Upper Stillwater Pipeline and Stillwater Tunnel. Should water be required to satisfy minimum streamflows in drought years, or should more than 285 $ft^3/s$ be released to the tunnel, the water will be directed back to Rock Creek by the Overflow and/or Drought Release Bypass Channel. This consists of two manual slide gates for drought releases up to 220 $ft^3/s$ and an overflow weir for excess tunnel flows and/or rapid drawdown of the reservoir. An open channel will convey this water back to Rock Creek. High water level alarms have been included to indicate when these conditions occur.

3. DOCS DIVERSION DAM

Docs Diversion Dam and Pipeline is built on the South Fork of Rock Creek. This pipeline system consists of an unregulated diversion dam, located higher than the Upper Stillwater Reservoir, diverting up to 100 $ft^3/s$ of water into the Strawberry Aqueduct and/or Upper Stillwater Reservoir depending upon operations. A bypass pipe will reintroduce the required fishery flows back into the South Fork.

The diversion structure consists of a reinforced concrete drop inlet structure leading to the feeder pipeline. Flows in excess of those required for diversion will pass over the inlet grating which is located at streambed elevation. Elevation of the top of active conservation is 8,198.0.

4. DOCS FEEDER PIPELINE

Docs Feeder Pipeline is 0.8 mile in length and will handle flows from 0 to 100 $ft^3/s$, dropping from the diversion structure down to the Upper Stillwater Pipeline. The only controls provided for on Docs Pipeline will be an ultra-sonic flowmeter and a manually operated butterfly guard valve located on the Docs Feeder Pipeline Connection Structure. The ultrasonic flowmeter signal will be transmitted to the Pipeline Control Structure, where the flow rate will be indicated, recorded, and totalized on registering instruments.

5. STILLWATER TUNNEL

The 8.1-mile-long Stillwater Tunnel has an inside diameter of 90 inches and a design capacity of 285 $ft^3/s$. The Stillwater Outlet Portal structure provides a connection between the Stillwater Tunnel and North Fork Siphon. Vehicular and man access for inspection and maintenance of the tunnel and siphon is provided at the structure, as well as ventilation openings to ventilate the tunnel and the free flow portion of the siphon during operation. Use of the vehicular access at the inlet structure is preferred because of the sloped ramp.

A manually operated cover is provided in the structure to open a 12-inch pipeline designed to drain water from the tunnel which may seep through the lining while the system is shut down for inspection and maintenance. This drain system is not intended to drain the tunnel when it is full, and the drain cover can only be opened when there is little or no water in the tunnel. There is a curb provided to insure this water does not flow out

of the structure through the vehicular access when the vehicular access door is open.

## 6. NORTH FORK PIPELINE

The North Fork Pipeline begins at the outlet of Stillwater Tunnel with 90-inch-diameter pipe designed for 285 $ft^3/s$ of free flow. From the outlet portal, the pipeline extends approximately 1,560 feet along the hillside to a point at which the siphon starts down the hillside. An 18-inch-diameter air vent is provided at this point to ventilate the transition from open to pressure flow.

## 7. NORTH FORK SIPHON

The North Fork Siphon tapers to a 72-inch-diameter pipe at this point and flows under pressure for approximately 4,660 feet across the North Fork Canyon. The downstream half of the siphon is designed for 305 $ft^3/s$. It is anticipated the upstream half of the siphon will convey less than 285 $ft^3/s$ in spring and summer when Hades Feeder Pipeline is conveying its full capacity. Under maximum flow conditions, the transition to pressure flow occurs at elevation 7,941.9. For smaller flows, the transition occurs at lower elevations within the pipe. This transition will approach the pool level in the siphon (elevation 7,917.64) as the flow approaches zero, see drawing 66-D-2281, Appendix A.

A tee intersection incorporated in the blowoff structure in the bottom of the canyon provides for 30 $ft^3/s$ of flow into North Fork Siphon from Hades Feeder Pipeline.

The downstream end of the siphon connects to the inlet of Hades Tunnel and is designed for 305 $ft^3/s$ with the flow changing from pressure to free flow at the Hades Inlet Portal structure.

### a. BLOWOFF STRUCTURE

The blowoff structure serves to house a number of features designed to aid in the operation and maintenance of both North Fork Siphon and Hades Feeder Pipeline.

A 24-inch butterfly valve (24 MBV) isolates and controls the flow from the Hades Feeder Pipeline into the North Fork Siphon. A single path ultrasonic flowmeter is included on the Hades line to allow monitoring of flow rates entering the siphon from Hades Creek Diversion. The valve and flowmeter will be operated and monitored from the blowoff structure.

Blowoff piping is provided to allow either the siphon or the Hades line or both to be drained. Each drain system has a 4-inch valve which will act as a guard valve to isolate the drainlines from the high pressure pipelines. When the gate valves are opened, the flow through each drain will be controlled by a 4-inch butterfly valve. Just downstream from the butterfly control valve on the drainline is a pressure guage with isolation valve. The pressure in the drainlines will be monitored to calculate velocity to insure the velocity in the drainline does not exceed 30 feet per second.

It is anticipated that the butterfly drain valves will be subject to cavitation problems and may need to be replaced periodically. This replacement can be done while the siphon remains in operation since the gate valves will isolate the drainlines from the high heads in the pipelines.

8. HADES CREEK DIVERSION DAM

The Hades Diversion structure will divert water into the 2.6-mile-long buried feeder pipeline for conveyance. It is a drop stream inlet with unheated trash-racks. Hades Feeder Pipeline (HFP) is a 30-inch pipeline that begins at the diversion structure and tapers to a 24-inch pipeline at approximately 575 feet from the North Fork Siphon (NFS). The 24-inch pipeline has a design flow of 30 $ft^3/s$. However, the diversion flow is unregulated and is controlled by the available pressure head at the diversion site. Therefore, when the streamflow is less than approximately 35 $ft^3/s$, the stream inlet will divert all streamflow into HFP except for a minimum downstream flow requirement of 1.5 $ft^3/s$. The maximum diversion flow in HFP when Hades Creek water surface at the diversion site is at flood elevation 8,005 is approximately 36 $ft^3/s$.

The 18- by 18-inch cast iron slide gate is a local manually controlled motor-operated gate that provides minimum downstream flows and continuous sluicing action. During normal operating conditions the gate will be partially open to provide approximately 1.5 $ft^3/s$ downstream bypass. Short-term full sluicing is allowed when required to clear large debris from the structure. The slide gate is heated to allow year-round operation.

The 30- by 30-inch cast iron slide gate is a local manually controlled motor-operated gate to be used to stop the diversion flow into Hades Feeder Pipeline when it is required to isolate and drain the line. The gate is fully open during normal operating conditions. The slide gate is heated to allow year-round operation.

The Hades Creek Water Level Recorder is a local continuous recorder indicating water depth through a "V" notch weir. Depths corresponding to 0 $ft^3/s$ through approximately 2.5 $ft^3/s$ will be recorded to verify the minimum stream bypass required for downstream water rights. Larger flow depths are not recorded. A one-year paper chart is produced as a permanent record of stream bypass flows.

9. HADES CREEK FEEDER PIPELINE

The Hades Creek Feeder Pipeline enters the Strawberry Aqueduct near the midpoint of the North Fork Siphon. The blowoff structure at this Tee houses the ultrasonic flowmeter, 24-inch motor-operated butterfly valve and other gauges and small valves. The blowoff structure serves to house a number of features designed to aid in the operation and maintenance of both North Fork Siphon (NFS) and Hades Feeder Pipeline (HFP).

A 24-inch butterfly valve is provided on the HFP side of the NFS-HFP tee intersection to isolate the HFP and NFS flows from each other. A single path ultrasonic flowmeter is included on the HFP to allow remote moni-

toring and recording of flow rates entering the NFS from HFP. The isolation valve and flowmeter will be operated and monitored from the NFS blowoff structure. Flow through Stillwater Tunnel must be controlled to not allow the combined flow entering Hades Tunnel to exceed 305 $ft^3/s$.

Blowoff piping is provided to allow NFS, HFP, or both to be drained. Each drain system has a 4-inch gate valve (4GV1 and 4GV2) which will act as a guard valve to isolate the drainlines from the high pressure pipelines if the downstream butterfly valves require removal for inspection or repair. The gate valves are fully open during normal operating conditions. When draining of NFS or HFP is required, the butterfly valves (4BV1, 4BV2, or both) shall be opened only the amount required to produce 60 $lb/in^2$ maximum pressure reading at pressure gauge with valve and stopcock. This will limit the velocity through the orifice plate to approximately 70 ft/s.

It is anticipated that 4BV1 and 4BV2 will be subject to cavitation damage and may need to be replaced periodically. This replacement can be done during operation of NFS and HFP by closing 4GV1 and 4GV2, which will isolate the drainlines from their high heads.

a. FILLING HADES FEEDER PIPELINE

The filling rate of Hades Feeder Pipeline must be restricted to 3 $ft^3/s$. This filling rate will create approximately 2 $lb/in^2$ pressure differential (the maximum recommended value) across the 2-inch air valves. The portion of the pipeline which is served by 2-inch air valves is from Station 45+00 to Station 156+00. Filling of this portion at the rate of 2 $ft^3/s$ will take approximately 5 hours. The portion from Station 10+00 to Station 45+00 may be filled at a rate of 5 $ft^3/s$ and will take approximately 0.5 hour to fill. Gate openings are 2 3/4 inch and 5 1/4 inch respectively.

b. DRAINING HADES FEEDER PIPELINE

The draining rate of Hades Feeder Pipeline (HFP) is restricted to 3 $ft^3/s$ at each blowoff structure. This will prevent excessive erosion of the outlet channels. When normal draining of HFP is required, the following sequence shall be followed:

(1) fully open 4B1 until air begins to enter at 2AV1 (approximately 3 hours)

(2) fully open 4B2 until air begins to enter at 2AV2 (approximately 3 hours)

(3) fully open 4B3 until air begins to enter at 2AV3 (approximately 1/2 hour)

(4) fully open 4B4 (drain time approximately 2 hours)

Isolated low points near each blowoff will require pumping to unwater the pipeline. The estimated volume of water to be pumped after gravity draining is listed below:

| Structure | Volume (gallons) |
|---|---|
| 4B1 | 5,500 |
| 4B2 | 19,100 |
| 4B3 | 12,400 |
| 4B4 | 8,300 |

Under emergency conditions all blowoffs may be opened fully without regard to sequencing. Prior to refilling, all blowoff valves shall be removed and inspected for cavitation damage.

## 10. HADES TUNNEL

The Hades Tunnel extends 4.2 miles from the North Fork Siphon to the West Creek Pipeline. It is designed to handle up to 305 $ft^3/s$ and is 8 feet 3 inches inside diameter. The Hades Tunnel Inlet Portal structure provides a connection between the North Fork Siphon and Hades Tunnel. Man access is provided to allow exit from the tunnel during inspection. No vehicular access to the portal will be provided at this location. Ventilation openings are incorporated in the structure to ventilate the tunnel and the portion of the siphon where flow changes from pressurized to free flow. Flow accretion is due to seepage into the tunnel.

A vehicle access into the tunnel has been provided at the outlet portal where the Rhodes and Win Feeder Pipelines enter Hades Tunnel outlet structure. Please see Paragraph 16. Rhodes Tunnel for additional information pertaining to inlet and outlet structures of both tunnels.

## 11. WIN DIVERSION DAM

Win Diversion Structure will divert water from Twin Creek into a buried 18 inch PVC feeder pipeline for conveyance. The diversion structure will be located about 1,100 feet upstream from the confluence of Twin and Wolf Creeks and will consist of a reinforced concrete drop inlet structure that will take flows up to 5 second feet into the feeder line. The remaining flow will pass over a grating which will be located at streambed elevation. A slide gate will regulate flows into the Win Feeder Pipeline.

## 12. WIN FEEDER PIPELINE

Win Feeder Pipeline is an 18-inch-diameter pipe, 3,400 feet long. It conveys the diverted water to the collection system at the head of the Wolf Creek Pipeline. Filling and drainage restrictions apply.

## 13. RHODES DIVERSION DAM

Rhodes Diversion will divert water (up to 30 $ft^3/s$) from Wolf Creek through an 18-inch feeder pipeline and an 18-inch sluiceway pipe. The structure consists of a cast-in-place drop inlet with trashracks and manually operated slide gates.

## 14. RHODES FEEDER PIPELINE

The Rhodes Feeder Pipeline is designed to handle flows up to 30 $ft^3/s$ and consists of approximately 700 linear feet of pipe. Flow-control structures (instrument shelters) are to be constructed on both Rhodes and Win Feeder Pipelines to regulate flow into the Hades Tunnel outlet structure.

## 15. WOLF CREEK PIPELINE

The buried Wolf Creek Pipeline will begin at the outlet portal of Hades Tunnel. The pipeline will be reinforced precast concrete pipe 7 feet in diameter with a carrying capacity of 325 $ft^3/s$. It will convey Bonneville Unit water across Wolf Creek Canyon, running in a southwesterly direction approximately 0.1 mile to the inlet portal of Rhodes Tunnel.

## 16. RHODES TUNNEL

The 0.8 mile length of Rhodes Tunnel is 8 feet 3 inch inside diameter and designed for a 325 $ft^3/s$ flow. This tunnel connects the Wolf Creek Pipeline and the West Fork Pipeline. The Rhodes Tunnel has a power cable and raceway centrally located at the top and for the full length of the tunnel. The cable enters and exits through a 4-inch-diameter metal conduit constructed within the concrete lining of the inlet and outlet closed transitions. The power cable connects to switchgear in the switchgear protective structure located alongside the Rhodes Tunnel inlet structure.

The flows through Rhodes Tunnel will be those through Hades Tunnel and additional flows which derive from the Win Diversion and the Rhodes Diversion or combinations thereof. Both diversions will feed into the system at the Hades Tunnel outlet structure.

The inlet and outlet structure has an air vent shaft with a 3- by 3-foot louver opening fitted with two 18- by 36-inch counter-balanced dampers to provide for air flow. These louvers should remain open during normal operation. They should be closed during an extended nonoperational period during the winter months to prevent the circulation of cold air.

a. ACCESS TO STRUCTURES

Before entering the Hades or Rhodes Tunnels, the conditions stated in Items of Special Importance - Tunnels, must be strictly adhered to.

Vehicular and personnel access to each of the tunnels is provided for at the outlet structures. Personnel access only is provided for at the inlet structures. This access is through a 2-foot-6-inch by 6-foot-8-inch metal door located on the side of the air shaft. Fixed and moveable ladders are provided.

For the Rhodes Tunnel, both vehicular and personnel access is provided for only through the access adit, by opening a hinged metal access door located about 10 feet inside the adit. The door is locked on the outside.

b. INLET STRUCTURES

Access for personnel only is provided for at each of the tunnel inlet structures.

17. WEST FORK PIPELINE

The West Fork Pipeline is approximately 4.2 miles long and conveys water from the Rhodes Tunnel outlet to the Vat Tunnel inlet. Class B and heavier 78-inch-diameter reinforced concrete cylinder pressure pipe with type R2 joints has been installed except between Approximate Stations 839+50 to 848+00 where steel pipe is installed. The pipe is buried with a minimum of 4 feet of cover under the West Fork Duchesne River road, a minimum of 5 feet of cover near the river, and a minimum cover of 3 feet elsewhere.

Steel pipe was required due to hillside instability and movement. Six buried sleeve-type couplings are provided to allow some movement of the steel pipe joints, i.e., opening of a joint due to downhill movement of surrounding earth material. Longitudinal restraint is provided at each coupling to prevent longitudinal separation of the pipe. Three expansion joints are provided to allow extension of the pipe. The pipe is coal-tar epoxy lined and coated and wrapped with the Polyken system to allow greater deflection of the pipe than would be possible with cement lining and coating. In addition, three expansion joint structures are provided through the earthflow area. The walls of the expansion joint structures are designed to resist at-rest earth pressures of 96 $lb/ft^2$ per foot of depth with a load factor of 1.7. Precast roof slabs are designed to support wheel loads equal to 150 percent of HS20 truck wheel loads. The roof slabs are post-tensioned to provide an integral roof slab with shear transfer between precast elements. The structures are designed to prevent the infiltration of ground water, and a drain is provided to release any water which accumulates within the structures.

Ancillary structures and features pertinent to and associated with the pipeline include a flow measuring structure, subsurface and horizontal drains, individual access manholes, blowoffs with manholes, air valves

with manholes, and air vents sized to provide for personnel access. Inclinometers have been installed along the alignment.

a. ANCILLARIES

Flow measuring structure. The flow measuring structure is located approximately 200 feet upstream from the Vat Tunnel inlet structure and houses a 78-inch flow tube, flow transmitter, and electrical installations. The reinforced concrete structure, 24 feet 4 inches long by 17 feet 4 inches wide, is insulated for wintertime operation. The structure is below ground and has a personnel access hatch and fixed ladder located in one corner of the structure; seven concrete hatch planks on the roof, centrally located above the 78-inch flow tube, provide access for repair or removal of the flow tube or other installations. The structure is designed for 1 foot of earth cover over the hatch planks, plus an allowable vehicular load equal to the H10-44 truck load on the loose earth.

Ventilation intake and exhaust piping is provided through the roof at opposite corners of the structure. A sump and sump pump are installed in the floor. The sump discharge pipe is embedded in the downstream wall and extends upward through the wall with the discharge outlet located near the top of the access facility. A frame drain pipe to drain water from the access cover and frame is embedded in and extends down through the wall to the sump.

Air valve with manhole structures. These structures are insulated, reinforced concrete covered, 60-inch-diameter reinforced concrete pressure pipe extending from the line pipe to ground level. The structures house combination air-inlet and air-release-type valve assemblies installed in conjunction with and on top of an access manhole, fixed access ladder, air vent piping, and a 6-inch-diameter by 6-inch-deep sump.

The valve with manhole installation is designed to release air during filling of the pipelines, to release any accumulation of air during the operation of the pipeline system, or to admit air to enter a reach of pipe during drainage operations. Air valves are specified at high points on the system.

An advantage of this combination is that the relatively large outlet nozzle for the manhole will act as a trap to collect air bubbles for discharge through the air valve. The butterfly gate valve installed between the pipeline and the air valve must be open at all times. When an air valve is being inspected, its gate valve also should be checked by closing it and then opening it. A petcock on the air valve is provided so that an inspector may ascertain that the valve is functioning properly. Opening the petcock should allow a small amount of air to be emitted, followed by a jet of water. If a large volume of air escapes, the air valve is not working as it should. Operation and maintenance of the air valves should be in accordance with the manufacturer's instructions.

Blowoff with manhole structures. These structures house blowoff valve installations and access manholes located just upstream from

the blowoff valves. The square-shaped, reinforced concrete structures extend from the fully concrete-encased line pipe to ground surface. Access is provided through a hinged metal cover on the top of the structure; a fixed steel ladder also is provided. Blowoffs are installed at low points in the pipeline to permit draining or flushing, if required.

Four of the required five blowoffs discharge to either 36- or 48-inch vertically installed reinforced concrete pressure pipe stilling wells. The blowoff at Station 822+00 extends 2 feet 6 inches above the floor of the structure and has a 125-pound cast iron blind flange which will require removal after draining operations to allow trapped water to be pumped out. Since the blowoffs are located in forested areas, care must be exercised in releasing the discharge to avoid damaging the surrounding landscape, by adjusting the valve opening.

During periodic inspections, the blowoff valves shall be opened and closed to check the valve operation. If water is discharged during this procedures, the valve shall be opened and closed slowly to prevent or minimize excessive pressure surges (drops or rises) due to hydraulic transients.

If it is desirable to unwater the pipeline completely, it will be necessary to insert a suction line into the pipe and resort to pumping. As air must be admitted to the pipe, air valves should be inspected before draining to ensure that they are in proper working order.

Operation and maintenance of the valves should be in accordance with the manufacturer's instructions.

Individual access manholes. Individual access manholes, other than those associated with the air valves and blowoff structures, have been provided on the pipeline at Stations 877+96 and 906+00 and are buried mortar-covered blind-flanged nozzle type.

Horizontal and subsurface drains. The horizontal drains are differentiated from subsurface drains in that they were to be installed a minimum of 4 feet beneath the pipeline invert prior to pipe trench excavation. The purpose for these horizontal drains was to help stabilize the hillside through which the trench passed by dewatering saturated material and/or to keep slopes from becoming saturated.

The perforated, 6-inch-diameter drains specified for the uphill side of the pipeline trench are identified as subsurface drains to distinguish their purpose from the purpose of the horizontal drains. Perforated pipe was specified to control water which could percolate through the select material used for bedding around the pipe and to control water which could saturate the existing troublesome geologic formations at various stretches along the pipeline alignment. These drains are designed to collect any water in the select material and safely discharge the collected drainage water.

During routine inspections of the pipeline, these drains should be inspected to ensure that the oulets are free of debris. The pipe

drain outlets and coarse gravel protective blankets should be inspected regularly for the presence of small animals and nests, sediment, weeds, and/or trash which may cause blockage.

Air vents. Air vents are installed at Stations 808+50 and 827+00 to allow large volumes of air to enter and exit the pipeline during draining and filling of the pipeline and during periods of flow less than design flow.

b. OPERATION AND FILLING PROCEDURES

The pipeline is designed for a maximum internal head of 250 feet and a maximum design flow of 325 $ft^3/s$. Under some flow conditions, three reaches of pipeline may perform as free-flow siphon inlets. These locations are from Station 752+00 to about Station 753+00, Station 808+50 to about Station 811+00, and Station 827+00 to about Station 829+00. The water in these reaches will flow at high velocities and will fill the pipe only partially. The air vents are provided at Stations 808+50 and 827+00 to accommodate airflow demands and prevent blowback reaches. The entire pipeline will run full and under pressure during operations at the design flow of 325 $ft^3/s$.

Filling. The filling rate should not exceed 16 $ft^3/s$.

Although the earth cover over most of the pipeline length exceeds 3 feet, a minimum of 3 feet of cover was specified. It was assumed that when upstream portions of the Strawberry Aqueduct are finished, there will be some flow in the pipeline at all times. With continuous flow, ice should not form in the pipe during the winter.

Additional cover over the pipe was provided at the West Fork Duchesne River crossing reaches in the flood plain along this river, and at other major drainage crossings of the pipeline to provide for the maximum anticipated local flood scour. However, to protect the pipeline in the flood plain (Station 834+00 to Station 906+00 and Station 936+00 to Station 967+00) from flotation during or after a severe flood, it was specified to fill this reach with water soon after it was completed by the contractor. The empty pipe will not float unless the cover is eroded to within about 3 feet of the top of the pipe.

Before filling the pipeline, a thorough inspection of all facilities first should be made including the following items:

(1) Determine which portion or portions of pipeline require filling and to what degree.

(2) The 8-inch butterfly valves at the air valve assemblies, located in the manholes at Stations 788+75 and 935+90, must be fully open.

(3) At each of the four blowoff with manhole installations which discharge to stilling wells, the blowoff valves initially should be opened to flush out any debris, then the valves should be

fully closed. The manhole covers should be bolted tight. At the blowoff at Station 822+00, the blind flange first must be removed and a temporary discharge line connected. Then the valve should be opened to flush out any debris, then fully closed. Replace the blind flange ensuring it and the manhole cover are bolted tight.

(4) Ensure that the flowmetering equipment in the flow measuring structure is functioning properly.

(5) The two air vents should be inspected to ensure that they are operational and that vent piping is free of obstructions.

(6) Inspection of Vat Tunnel inclusive of the inlet and outlet structures must be made to ensure that all equipment, tools, construction materials, loose concrete and rocks, and any other objects which could damage the tunnel or structures are removed. No personnel should be permitted in the pipeline, tunnel, or structures during the filling and/or operation of West Fork Pipeline.

(7) Each of the two motor-operated slide gates, two motor-operated butterfly valves, and flowmetering equipment associated with the Vat Feeder Pipeline should be in an operational and working status. Flow from Vat Diversion may be used to partially fill West Fork Pipeline.

(8) After the filling operation, check the ground along the full length of the pipeline and around the blowoffs for any signs of seepage or possible breaks. If seepage or a break is detected, the pipe must be drained and the defects repaired.

c. DEWATERING

Complete unwatering of West Fork Pipeline can be accomplished only through the blowoffs. The maximum rate of dewatering should not exceed 16 $ft^3/s$.

Before any dewatering operation is begun, operating personnel should evaluate each blowoff location to determine the capability of local natural drainage channels to transport the water to be discharged. Consideration should be given to the cumulative effects of discharge from several blowoffs in the same basin with respect to the carrying capacity of lower channels. Care must be exercised in releasing the discharge to avoid damage to the surrounding landscape.

When a portion of pipeline or the entire pipeline is required to be drained, the blowoffs highest in the elevation should be opened first and drained. Unwatering at successively lower levels should take place in sequence. The object of this procedures is to reduce the volume and erosive power of the initial blowoff discharge. The blowoff butterfly valves should be opened or closed at a slow rate in order to minimize pressure drops or rises caused by water hammer.

A complete dewatering operation will require the use of a portable pump to remove residual water after first draining as much water as possible by gravity. The residual water in the line then should be removed by using a portable pump with a flexible intake hose which can be inserted into and lowered down the riser pipe until its intake end is approximately at the low point of the pipeline invert. The portable pump should be of a type which is operated by a pneumatic or electric motor to avoid carbon monoxide poisoning.

Each blowoff butterfly valve should be closed immediately after the adjacent pipe is drained so that insects, rodents, debris, etc., cannot enter the valve assembly or the inside of the pipeline. Air valves should be inspected before draining to ascertain that they are in proper working order to admit air. After the system has been in routine operation for some time, required draining should, when possible, be scheduled during periods of low flows or non-use. A good system of communications is a prerequisite for an efficient filling or unwatering operation.

Refilling of the pipeline should be accomplished in the same manner as the initial filling.

d. NORMAL OPERATION

After the pipeline is filled and all ancillaries have been determined to be functional, the flow through the pipeline will have to be regulated so as not to exceed 325 $ft^3/s$.

The flow through the pipeline will derive from (1) releases from Upper Stillwater Reservoir, (2) the Hades Diversion, (3) the Rhodes Diversion, (4) the Win Diversion, or (5) a combination thereof.

18. VAT DIVERSION DAM

The features for the Vat diversion were constructed under Specifications No. DC-7361. The principal components of the diversion are an embankment dam and its appurtenant spillway, sluiceway, headworks complex, stream bypass and flow measuring structure, and bridge. Other components are the Vat Feeder Pipeline and its flow control structure.

The diversion, located on the West Fork Duchesne River, is designed to maintain a regulating reservoir of 40 acre-feet and is capable of diverting up to 300 $ft^3/s$ of water to the Strawberry Aqueduct. Delivery is made through the Vat Feeder Pipeline to the Vat Tunnel inlet portal structure. Water will be diverted throughout the year. The diversion will be automatically controlled and operated onsite, dependently on West Fork Pipeline flow.

The expected sediment load at the dam is 10,630 t/yr. Bedload is expected to be 25 percent of the suspended sediment (2,660 t/yr). Sediment may have to be removed from the reservoir at approximately 8-year intervals.

a. EMBANKMENT DAM

The zoned compacted embankment dam is approximately 575 feet long with a maximum height of 22 feet. The crest is 20 feet wide and provides for vehicular access to the Vat Tunnel inlet portal area.

Appurtenant to the dam are an ogee-type spillway, a radial-gated sluiceway, a headworks complex, a gated stream bypass, two gated outlets to the Vat Feeder Pipeline, and a bridge over the spillway and sluiceway.

The crest elevation is set to provide a minimum freeboard of 4.0 feet above a 50-year floodwater surface and a minimum freeboard of 3.0 feet above a 100-year floodwater surface.

Inspection of the embankment should be made at frequent intervals, especially after floodflows or periods of sustained high-velocity winds. Special attention should be given to evidence of cracks, seeps, sloughs, or subsidence, and damage to the slope protection such as riprap displacement and other signs of erosion or deterioration. Remedial measures should be taken if any of these conditions exist.

b. SPILLWAY

The 50-foot-wide ogee-type spillway is designed to pass a 50-year floodflow of 1,500 $ft^3/s$ at a reservoir water surface elevation of 7,814.9. The crest elevation is 7,811.00 feet, which is 0.5 foot higher than the reservoir water surface required to divert 300 $ft^3/s$ into the headworks.

Weep holes in the chute blocks at the downstream end of the gravity section are connected to a continuous pipe drain inside a zoned sand-and-gravel filter. The purpose of this drainage system is to reduce uplift pressures underneath the structure. A periodic examination of the weep holes should be made to see if they are functioning properly. The discharge normally should be clear. If the discharge becomes turbid, a failure of the inverted filter is probable and an immediate investigation is indicated. The weep holes should be open at all times to allow free drainage of the filter and prevent excessive uplift. If the discharge from the weep holes becomes projected, indicating both excessive pressure and excessive discharge, an investigation should be made to determine the source of the leakage and corrective action should to taken.

The riprap downstream from the structure should be inspected after each flood flow, and all removed or displaced riprap should be replaced. The crest of the spillway should be kept free of fallen trees and other debris. A periodic inspection should be made of the general condition of the concrete with repairs being made as necessary.

c. SLUICEWAY

The 10-foot-wide sluiceway is provided for sluicing sediment and debris that accumulates in front of the headworks structure. A 10- by 18-foot motor-operated radial gate is provided and is heated for winter operation. The gate position is indicated in the control house.

The radial gate may be operated electrically either from the control house or from a pushbutton station near the gate. When the selector switch in the control house is turned to the "LOCAL" position, the radial gate may be operated electrically from the control house. When the selector switch is turned to the "MANUAL" position, the radial gate may be operated electrically from the pushbutton station.

When the gate is closed, it will have 1 foot of freeboard above the 50-year floodwater surface. The gate should be opened periodically to sluice any sediment that may be deposited in front of the headworks. The gate can be isolated for maintenance or repair by insertion of stoplogs in the grooves near the upstream end of the structure.

d. HEADWORKS COMPLEX

The complex includes both the headworks structure and the control house which houses the automatic control systems.

The headworks has three gated outlets, a 24-inch-diameter pipe outlet for the stream bypass, and 24- and 66-inch-diameter pipe outlets for the Vat Feeder Pipeline. The headworks also contains a trashrack, a concrete curtain wall which extends below ice cover to prevent ice damage to the trashracks and minimize ice problems in the headworks, a 17- by 3-foot hatch to provide access for installation and maintenance of the gates, and two water-surface-level measuring wells (one to measure the reservoir water surface and one to measure the water surface in the headworks, if desired in the future).

The top of the operating deck (El. 7,816.00) was set a minimum of 1 foot above the water surface for a 50-year flood.

Up to 3 feet of ice cover is anticipated in the reservoir during the winter. The headworks is designed to permit diversion in the winter with this ice cover. The gates are heated for winter operation. The trashrack is set on a 1:1 slope to facilitate cleaning.

The slide gates for the outlets to the Vat Feeder Pipeline should be either fully opened or fully closed. The gates may be operated electrically from either the control house or by a pushbutton station near the gates. The gates also may be operated manually by a handwheel.

The main controls for the gates are in the control house. A selector switch turned to the "REMOTE" position will allow operation of a slide gate from a remote station. When a selector switch is turned

to the "LOCAL" position, the slide gate may be operated electrically from the control house. When a selector switch is turned to the "MANUAL" position, the slide gate may be operated from a pushbutton station located by the gate.

e. STREAM BYPASS AND MEASURING STRUCTURE

The stream bypass is required to pass streamflow necessary for fish preservation and other water rights. The stream bypass consists of 24-inch precast concrete pressure pipe leading from the headworks to the stream bypass measuring structure which contains a 5-foot standard suppressed rectangular weir and a floatwell. Due to the short approach to the weir, baffles were installed to quiet the flow. Two 5- by 5-foot metal-hinged covers are located on top of the measuring structure. One is for access to rate the weir, and the other is for access to clean in front of the baffles.

The 24-inch motor-operated slide gate and the 5-foot weir are provided to control and measure the bypass flows. Signals from the floatwell transmitter are received at the control house for automatic gate control. However, manual control of the gate is possible by use of a pushbutton control at the gate, but only after selection of the manual control mode in the control house is made.

The 5-foot standard suppressed rectangular weir is capable of measuring flows from 1.5 to 30 $ft^3/s$. Flow over the weir can be computed from the formula $Q = 3.33\ L\ H^{3/2}$; where Q is the flow (cubic feet per second), L is the length of weir (ft), and H is the height (ft) of the upstream water surface above the weir crest.

The stream bypass measuring structure control equipment is provided to control the bypass flow by automatically controlling the 24- by 24-inch slide gate to the value set on the rate setter. The equipment has a control operating range of 1.5 to 30 $ft^3/s$. The control system is required to indicate, record, and totalize the bypass flow within $\pm 3$ percent of actual flow and control the flow within $\pm 4$ percent of actual flow.

19. VAT FEEDER PIPELINE

The Vat Feeder Pipeline and flow control structure provide the means to divert and control up to 300 $ft^3/s$ of water to the aqueduct system, with delivery being made at the inlet portal to Vat Tunnel. Parallel 24- and 66-inch-diameter pipelines connect to the motorized slide-gated outlets at the headworks. The 24-inch pipe is designed for flows of 3 to 30 $ft^3/s$ and the 66-inch pipe is designed for flows of 30 to 300 $ft^3/s$. The 24-inch pipe tapers to 20 inches and connects to the 66-inch pipe within the flow control structure. Beyond the flow control structure, the feeder pipeline consists only of 66-inch-diameter pipeline.

a. PIPE INSTALLATION

Both the 24- and 66-inch pipe from the outlets to the flow control structure are Class D reinforced concrete pipe with the 66-inch pipe on a concrete cradle and the 24-inch pipe fully encased in concrete. The 66-inch pipe from the flow control structure to the inlet portal structure is either Class C or D reinforced concrete pipe. Because of these relatively short installations and the system hydraulics, air valves, blowoffs, or inspection manhole installations are not provided on the line pipe.

However, an 8-inch blowoff and blind-flanged drain and a 1-inch air valve assembly on the 66-inch feeder pipeline and a 1-inch air valve assembly and a 1-inch drain on the 20-inch feeder pipeline are provided on the manifold piping located within the flow control structure.

The 8-inch blowoff and drain provide the means to unwater the 66-inch pipeline. As air must be admitted to the pipeline during unwatering, the air valves should be inspected to ensure that they are in proper working order.

b. FLOW CONTROL STRUCTURE

This reinforced concrete structure houses a 20-inch flowmeter and 20-inch rate-of-flow control butterfly valve, and 66-inch flowmeter and 66-inch rate-of-flow control butterfly valve to control the flow to Vat Feeder Pipeline. The flowmeters will measure the flow through the pipelines and provide flow signal input to registering instruments and control equipment located in the control house.

The control equipment for the 20-inch rate-of-flow control valve will automatically control the valve to modulate the flow when the reservoir water surface is between elevation 7,809.50 and 7,809.75 and control the flow to the value set on the rate setter. The equipment has a control operating range from 3 to 30 $ft^3/s$.

The control equipment for the 66-inch rate-of-flow control valve will automatically control the valve to modulate the flow when the reservoir water surface is between elevation 7,809.75 and 7,810.50 and control the flow to the value set on the rate setter. The equipment has a control operating range from 30 to 300 $ft^3/s$. In addition to providing modulating and rate set control, the control equipment will automatically control the 66-inch butterfly valve to throttle the flow to Vat Feeder Pipeline so the combined flow with West Fork Pipeline to Vat Tunnel is limited to a maximum flow of 475 $ft^3/s$.

Electronic trips are provided in the control circuit to close the 20-inch valve and open the 66-inch valve at reservoir elevation 7,809.75 on a rising reservoir and to close the 66-inch valve and open the 20-inch valve at reservoir elevation 7,809.75 on a falling reservoir.

## 20. VAT TUNNEL

Vat Tunnel lies between West Fork Pipeline upstream and Currant Creek Reservoir downstream. The approximately 7.3-mile-long, 8-foot-3-inch inside diameter, concrete-lined tunnel was machine excavated to a circular shape. The tunnel has 39 cast bronze station markers, numbered 990 through 1370 in increments of 10, installed on the side of the tunnel.

### a. HYDRAULICS

The flow through Vat Tunnel will be the individual flow either through West Fork Pipeline or from the Vat Diversion, or a combination thereof. The Vat Diversion feeds into the system at the inlet structure to Vat Tunnel. Based on a capacity of 475 $ft^3/s$, the velocity in the tunnel will be 11.04 ft/s.

Vat Tunnel may not pass a combined flow greater than 475 $ft^3/s$ which derives from the Vat diversion (maximum 325 $ft^3/s$). The Vat Diversion is designed to divert flows so that the combined flow from the two pipelines will not exceed 475 $ft^3/s$. Releases from Upper Stillwater Dam (Part II) are to be operated so that the Vat Diversion will divert close to maximum flow.

The Vat Tunnel outlet consists of a closed transition connected to a baffled apron drop which, in turn, feeds into an open 16-foot-wide channel to Currant Creek Reservoir.

Piezometer and Floatwell Installations. Piezometer and floatwell lines installed in the tunnel lining extend from the inlet portal 220 feet into the tunnel.

These lines connect to a 4-inch stand pipe, a water level recorder, and a water level well pipe installed in the inlet portal structure.

At the tunnel outlet portal, two piezometer lines are installed in the tunnel lining. The lines begin approximately 250 feet inside the tunnel and extend downstream where they connect to 2-inch-diameter pipe wells installed vertically in each side of the headwall.

The purpose of piezometer installations is to measure water depths in the tunnels at a quiescent location. The information gained from a program of measurements can be used to evaluate the actual hydraulic roughness, to observe changes in the tunnel roughness over time, and to correlate flow depths with measured flows.

### b. ACCESS TO STRUCTURES

Vehicular access to the tunnel interior is not provided for, except in extreme emergency. Emergency vehicular access can be accomplished at the outlet portal by either lowering vehicles by crane or by providing an earth ramp into the baffled apron drop. Either method will require extreme caution to prevent damage to structures. Access is also available at the inlet portal by removing concrete covers.

Personnel access only is provided for at the tunnel inlet portal structure. This access is through a metal door located on the side of the air vent shaft. The door is locked on the outside. Fixed and moveable aluminum ladders are provided.

c. SHUTDOWN OF TUNNEL

The following procedures should be followed to shut down Vat Tunnel:

a. All upstream diversions, tunnels, and pipelines must be shut down to prevent flow through West Fork Pipeline.

b. The Vat Diversion headworks complex, spillway, and bypass facilities should be inspected to ensure that they are in operational status and clear of debris in front of the structures.

c. The 24-inch motor-operated slide gate on the stream bypass should be fully opened.

d. Initially, the 20-inch and 66-inch motor-operated butterfly valves within the flow-control structure will be in a position determined by the automatic control system.

With the West Fork Pipeline shut down, the automatic control system will be diverting the maximum available flow through Vat Diversion. The automatic flow controllers at the Vat Diversion Dam Control House should be used to slowly reduce the flow in the Vat Feeder Pipeline to zero. The butterfly valves then should be checked under manual control to ensure that they are closed.

e. Fully close the 24-inch and 66-inch motor-operated slide gates at the headworks.

21. OPEN CHANNEL NO. 1

This open channel is designed to carry up to 475 $ft^3/s$ of water from the baffled apron drop at the outlet end of Vat Tunnel into the Currant Creek Reservoir. This short section of canal is 16-foot wide with side slopes of 2.1. It appears to be stable and well suited to the fluctuating water surface of the reservoir.

22. CURRANT CREEK DAM AND RESERVOIR

See Standing Operating Procedures for Currant Creek Dam.

The Currant Creek Dam outlet works is designed to provide a discharge capacity of 620 $ft^3/s$ to Currant Creek Pipeline when the reservoir water level is at the bottom of the active conservation pool elevation 7,674. This volume will pass through Currant Creek Pipeline, Currant Tunnel, Layout Siphon and Tunnel, and Water Hollow Siphon and Tunnel: provided that water is not being diverted into the system by either or both the Layout Creek and Water Hollow Diversions. Each diversion is designed to divert a maximum of 20 $ft^3/s$.

IMPORTANT: The outlet works and the diversions must be operated so that the design capacity of 620 $ft^3/s$ is not exceeded for any one of the features.

## 23. CURRANT CREEK PIPELINE

Currant Creek Pipeline was completed in 1977 and links Currant Creek Reservoir with Currant Tunnel. The siphon is a buried cast concrete pipeline 10 feet in diameter designed to hold up to 620 $ft^3/s$. It begins at the outlet works of Currant Creek Dam on Currant Creek and has a steel liner inside the original 4,291 foot pipeline.

## 24. CURRANT TUNNEL

Currant Tunnel extends 1.7 miles from Currant Creek Pipeline to Layout Creek Siphon. The inlet portal is located on a steep side slope adjacent to Currant Creek. The outlet portal is located 9,131 feet away on the north side of Layout Canyon. The tunnel was cut with a tunnel boring machine at 13 feet and then lined with concrete to 10 feet 10 inches in diameter This tunnel has a 620 $ft^3/s$ capacity.

## 25. LAYOUT CREEK DIVERSION STRUCTURE

The Layout Creek Diversion Structure consists of a reinforced concrete drop inlet structure, with up to 20 $ft^3/s$ intake flow going to the 18-inch to 15-inch diameter feeder line and the remainder of the flow to the sluicepipe. Flows in excess of those required for diversion and sluicing will pass over a grating located at the streambed elevation.

## 26. LAYOUT CREEK FEEDER PIPELINE

The Layout Feeder Pipeline extends 4,323 feet from Layout Creek Diversion Structure to the Strawberry Aqueduct, joining at the outlet portal access structure of Currant Tunnel. It is located along the left side near the bottom of the canyon. Open flow meters located in a box near the headworks to the diversion dam measure flows diverted into the aqueduct. A filling control valve exists at the Currant Tunnel outlet structure.

## 27. LAYOUT SIPHON

The Layout Creek Siphon design capacity is 620 $ft^3/s$ at a velocity of 7.16 $ft/s$. Layout Siphon passes under the Layout Creek streambed area and connects the upstream Currant Tunnel to the downstream Layout Tunnel. The 132-inch-inside-diameter precast reinforced concrete pressure pipe must have a minimum 6-foot cover where it passes beneath the streambed. This minimum cover must be maintained during the life of the structure. When the siphon has been drained for repair or maintenance, it should be filled at a flow rate not to exceed 40 $ft^3/s$. The 200-foot-long siphon can be drained only by pumping from either or both ends, as blowoff or other draining facilities have not been provided due to the relatively short length of the siphon. The pump should be of a type which is operated by a pneumatic or electric motor to avoid carbon monoxide poisoning.

## 28. LAYOUT TUNNEL

Layout Tunnel was drilled 13 feet in diameter with a mechanical mole for 17,355 feet. The concrete lining leaves the inside diameter at 10 feet 10 inches. The 3.29-mile tunnel goes through the high ridge from Layout Creek to Water Hollow Creek. The Currant, Layout, and Water Hollow Tunnels are connected with creek crossing structures consisting of inlet and outlet access structures and reinforced concrete pipe siphons. The design capacity for Layout Tunnel is 620 $ft^3/s$ at a velocity of 8.60 ft/s.

## 29. WATER HOLLOW SIPHON

The Water Hollow Siphon design capacity is 620 $ft^3/s$ at a velocity of less than 8 ft/s. The 290-foot-long siphon passes under the Water Hollow Creek streambed and connects Layout Tunnel to Water Hollow Tunnel. The approximately 290-foot-long Water Hollow Siphon is 132-inch-inside-diameter precast reinforced concrete pressure pipe. The siphon has a minimum 6-foot cover where it passes beneath the streambed. This minimum cover must be maintained during the life of the structure. Following periods when the siphon has been drained for repair or maintenance, the siphon should be filled at a flow rate not to exceed 40 $ft^3/s$. The siphon can be drained only by pumping from either or both ends, as blowoff or other draining facilities have not been provided due to the relatively short length of the siphons. The pump should be of a type which is operated by a pneumatic or electric motor to avoid carbon monoxide poisoning.

## 30. WATER HOLLOW DIVERSION STRUCTURE

The only portion of the Strawberry Aqueduct designed to pond water (between Currant Creek Dam and the enlarged Strawberry Reservoir) is the diversion structure at Water Hollow. Water Hollow Diversion Dam is located on Water Hollow Creek, in Wasatch County in North Central Utah.

Water Hollow Diversion Structure is a reinforced concrete structure consisting of a 24-foot-long overflow wier section, a sluiceway and bypass channel, and a headworks. Protective dikes extend from the diversion dam to each side of the hollow. The combined dikes are approximately 175 feet long, with a maximum height of 14 feet above the original ground surface. There is an access road on the left dike. Riprap protection is provided on both the upstream and downstream slopes. An inspection of the dikes should be made at frequent intervals, especially when the reservoir water surface is lowered, for evidence of cracks, seeps, sloughs, or subsidences, and damage to slope protection such as displacement of riprap and other signs of serious erosion or deterioration. If any of these conditions exist, remedial measures should be taken.

The spillway is 25 feet wide at the crest. The crest elevation is 7,644.00, which is approximately 6 inches higher than the reservoir water surface elevation required to divert 20 $ft^3/s$ into the headworks.

The riprap upstream and downstream from the spillway, sluiceway, and abutments should be inspected when the reservoir water surface is lowered, and all removed or displaced riprap should be replaced as soon as possible

after each flood flow. The crest of the weir should be kept free from fallen trees and other debris. A periodic inspection should be made of the general condition of the concrete, and all necessary repairs made.

Flow through the sluiceway structure is controlled by one 24- by 24-inch motor operated cast iron slide gate. The gate should be opened periodically to sluice any sediment that may be deposited in front of the headworks. A heating unit has been installed on the gate for year-round operation. Maintenance, adjustment, and lubrication of the slide gate and motor-operated lift are to be in accordance with manufacturer's instructions.

Flow through the headworks is controlled by a 12-inch-diameter motor-controlled cast iron slide gate for flows of 0 to 2 cubic feet per second, and a 30-inch-diameter motor-controlled cast iron slide gate for flows of 2 to 20 cubic feet per second. Both gates are heated so that diversions can be made from October to July, but in some years, there may be diversions during the entire year. The gates are operated by remote control from a central control station. A trashrack is mounted on the front of the headworks. The trashrack must be removed for winter operation.

The headworks structure has a baffle wall in front of the gates to protect the gates from ice thrusts during the winter. Each spring the baffle wall should be inspected and repaired, if necessary, before the trashracks are installed.

The meter box is located 19.3 feet downstream from the headworks structure. It is a concrete box with an insulated access cover. The meter box is heated for operation during the winter months. There are two pipes entering the box; one is a 12-inch-diameter pipe to carry flows from 0 to 2 cubic feet per second, and the other is a 30-inch-diameter pipe to carry flows from 2 to 20 cubic feet per second. The flows in each pipe are measured by flowmeters. A 21-inch-diameter outlet pipe, Water Hollow Feeder Pipeline, conveys the water from the meter box to Water Hollow Tunnel.

The gaging station is located on Water Hollow Creek. The gaging station measures and records all streamflows that pass the diversion dam. It is a rockfill structure with a 49 foot wide concrete crest at elevation 7,630.50. Near the center of the overflow weir is a concrete box with a "V" notch for measuring low flows. A concrete measuring well and recording house are located on the left bank of Water Hollow Creek. A 2-inch plastic pipe connects the measuring well and the box structure. The rockfill should be inspected periodically and all necessary repairs should be made.

Various size cast iron slide gates with motor-operated lifts are installed on the Water Hollow diversion Dam headworks structure to control the flow of water through the headworks and sluiceway. The gates are as follows:

a. Feeder pipeline - One 12-inch-diameter slide gate

b. Feeder Pipeline - One 30-inch-diameter slide gate

c. Sluiceway - One 24- by 24-inch slide gate

The gates and lifts are designed to operate under full waterhead. The gate lifts are equipped with two-button momentary contact-type pushbutton control units. A mechanical dial-type position indicator is located on each motor-operated lift, and a handwheel is provided for manual operation of each gate.

To prevent ice from forming on slide gates, electric heating cable is fastened around the gate frames.

The gates will be operated by the pushbuttons located on the motor operator stands. When necessary, the gates can be operated by the handwheels.

The heating cable is Chromalox, a product of Chromalox Comfort Conditioning Division, Emerson Electric Company, 8100 Florissant Avenue, St. Louis, Missouri 63166.

Both the safety of the structure and good operation and maintenance practices require that each gate be tested to confirm that it will operate as designed.

Exercising and operational testing should use electric power and hand crank sources to ensure the performance of each. All exercising and testing results should be recorded and dated in the operating log book.

CAUTION: IF DURING ANY OF THE TESTS THE GATE (VALVE) WILL NOT CLOSE FROM ANY POSITION OR OTHERWISE MALFUNCTIONS, STOP THE TESTS AND ATTEMPT TO DETERMINE THE CAUSE OF THE MALFUNCTION AND CORRECT IT. CONTACT THE UTAH PROJECTS OFFICE BEFORE PRECEEDING WITH FURTHER OPERATIONAL TESTING.

Each gate or valve associated with releasing reservoir water through an oulet works, shall be exercised through a complete opening and closing annually under a fullwater head condition or with the outlet works unwatered.

All required lubrication and general maintenanc of equipment should be done prior to operational testing and exercising. See the DOC page 6 for details.

31. WATER HOLLOW FEEDER PIPELINE

Water Hollow Diversion Dam intercepts Water Hollow Creek and diverts a part of its flow into the Water Hollow Feeder Pipeline. Water Hollow Feeder Pipeline conveys the diverted water 580 feet to the access structure on the downstream end of Water Hollow Siphon. Here the diverted water joins flows from Currant Creek and Layout Creek diversions and enters Water Hollow Tunnel which conveys the combined flows to Strawberry Reservoir. Water Hollow is a fairly narrow, steep-sided canyon. The feeder pipeline is located along the canyon bottom.

32. WATER HOLLOW TUNNEL

This tunnel was drilled 13 feet in diameter with a mechanical mole then a concrete lining of 10 feet 10 inches was completed in June 1971. The

first water from Water Hollow Creek was diverted into the tunnel beginning in December 1971. The 4.1-mile-long tunnel, which begins at Water Hollow Creek and ends at Strawberry Reservoir, is the terminal section of Strawberry Aqueduct and has a capacity of 620 $ft^3/s$. The material (spoil) excavated from Water Hollow Tunnel was deposited in an area below the old U.S. Highway 40 which will eventually be inundated by the enlarged Strawberry Reservoir.

33. OPEN CHANNEL NO. 2

This open channel is designed to carry up to 620 $ft^3/s$ from the outlet end of Water Hollow Tunnel into Strawberry Reservoir. Total length of canal is 5,405 feet and 6 drops lower the water over 70 feet. The lower 5 drops are baffled apron drops and will be inundated depending upon the elevation of the reservoir. The upper drop is equipped with a 20-foot Parshall Flume, a measuring well, and a baffled apron drop. Strawberry Aqueduct diversions into Strawberry Reservoir were initiated in December 1971.

34. ENLARGED STRAWBERRY RESERVOIR

See Standing Operating Procedures for Soldier Creek Dam.

## B. OPERATING INSTRUCTIONS COORDINATION WITH DOC

The Strawberry Aqueduct collection system is designed for year-round operation. Initially and until the installation of the remote control facilities, the features will require manual operation on site in accordance with these criteria, the "Designers' Operating Criteria - Currant Creek Dam," the final "Designers' Operating Criteria - Water Hollow diversion Dam," and the "Designers' Operating Criteria - Strawberry Aqueduct."

### 1. OUTLET WORKS

The descriptions of the outlet works are contained within the individual feature write up.

### 2. SPILLWAY

The spillway descriptions are contained within the individual feature writing.

### 3. ELECTRICAL SYSTEM AND EQUIPMENT

The electrical system is written up within the individual feature, with the exception of Water Hollow Diversion Dam, which will appear here.

The incoming single-phase, 120/240-volt, 60-hertz, 3-wire (grounded neutral) electric service is supplied from the local distribution system of a commercial power company. The service entrance conductors terminate on the main breaker located in the electrical control board.

#### a. ELECTRICAL CONTROL BOARD

The electrical control board is located outdoors adjacent to the meter box structure and contains molded case air circuit breakers. The breakers afford both overcurrent and short-circuit protection to the branch circuits extending from the electrical control board. The branch circuits are shown on Drawing 66-D-610, Appendix A. In addition to providing branch circuit protection as indicated above, the breakers also serve as a means of disconnecting the individual circuits from the electric source. The general arrangement of the electrical control board is indicated on Drawing 66-D-611, Appendix A. The electrical control board supplies electric power to the following equipment:

(1) Slide gate motors

(2) Slide gate heating equipment

(3) Headworks lighting and receptacles

(4) Meter box lighting and receptacles

(5) Trashrack heating equipment

(6) Gaging station stilling well lighting and receptacles

b. GROUNDING SYSTEM

The basic grounded electrode for the diversion dam consists of a No. 4/0 AWG, bare copper cable ground mat under the structure, as shown on Drawing 66-D-611, Appendix A. The conduit system, metal enclosures containing electrical equipment and devices, and other metalwork with which a person might come in contact during operation or maintenance, are connected to the grounding system. The intended purpose of the grounding system is to conduct static charges to ground and to limit the maximum potential of the circuits to ground due to the application of normal voltages to these circuits.

c. GATE HOIST MOTOR CONTROL EQUIPMENT

Each hoist motor and associated motor starting equipment (contained in its own cabinet) are both located on the hoist pedestal. The electrical service to the gate hoist motor is supplied from the electrical control board. A molded case circuit breaker located in the motor starting equipment enclosure provides a means of disconnecting the motor at the motor and also provides short-circuit protection for the motor. The reversing starter affords the motor both overload and undervoltage protection. Operation of the starter is controlled by momentary contact type RAISE-LOWER pushbutton units located in the motor control equipment enclosure.

4. AUXILIARY EQUIPMENT AND SERVICE SYSTEMS

a. LIGHTING SYSTEMS

The lighting system for the spillway, sluiceway, and headworks structure consists of pole-mounted, standlight-type lighting fixtures and single weatherproof receptacles for convenience outlets located on the deck of the structure, as shown on Drawing 66-D-611, Appendix A.

The lighting system for the gaging station stilling well structure consists of a bare lamp outlet and a single weatherproof receptacle for a convenience outlet located in the stilling well, as shown on Drawing 66-D-612, Appendix A.

The lighting system for the meter box structure consists only of a single weatherproof receptacle for a convenience outlet located in the meter box structure.

The lighting systems are served by 120-volt, 2-wire, and 120-240-volt, 3-wire branch circuits originating at molded case circuit breakers in the electrical control board, as shown on Drawings 66-D-610, 66-D-611, and 66-D-612, in Appendix A. All branch circuits are controlled by the circuit breakers in the electrical control board.

All lighting fixtures and lighting outlets are provided with 200-watt incandescent lamps. All receptacles for convenience outlets are 15-ampere, 125-volt, 2-pole, 3-wire, grounded, polarized type.

b. METER BOX STRUCTURE HEATING SYSTEM

(1) GENERAL

The heating system in the meter box structure is designed to maintain a temperature above 45° F in the meter box. Heating in the meter box structure is provided by an explosion-proof natural convection heater. Explosion-proof units were used in order to provide waterproof units. The heater is rated 3 kilowatts at 277 volts, single-phase, 60 hertz, but is operated on 240 volts, single-phase, 60 hertz.

(2) OPERATION

The operation of the heating system in the meter box structure is automatic. The heater is controlled by a thermostat installed in an explosion-proof enclosure for watertightness. The thermostat is set to energize the heater when the space temperature falls below 45° F.

(3) MAINTENANCE

The heater should be inspected periodically. At the time of inspection, particular attention should be directed to loose fastening devices and to the condition of the housing and heating elements. The thermostat should be inspected periodically for proper calibration and operation.

The equipment manufacturers' recommendations for service and maintenance of the natural convection heater and thermostat should be followed.

## C. SPECIAL INSTRUCTIONS

### 1. SLUICING PLAN

The term sluicing is used to describe the action taken to pass rocks, sand, and dirt through or around a diversion structure. The material passed through is normally considered bedload of a stream. In order for a diversion structure to work properly it must divert the water from the stream but not allow this bedload material to enter into the diversion pipeline. If this bedload material were allowed to get into the pipeline it would cause significant damage to the pipeline and tunnels of the Strawberry Aqueduct System. Therefore, the diversion structures are designed to remove this bedload from the water and pass it on down the stream through sluicing actions.

The material trapped in a diversion structure and then sluiced, is primarily gravel and sand. Most of the silty sediments are suspended in the water and pass through the diversion structures without settling out.

The 404 Permit obtained from the U.S. Army Corps of Engineers, for construction of the Strawberry Aqueduct system required that we develop a sluicing plan for the Strawberry Aqueduct. The following plan fulfills this requirement of the 404 Permit.

Almost all of the structures which divert water out of streams into the Strawberry Aqueduct require sluicing in order to maintain their usability. The exceptions to this are the Currant Creek Dam and the Upper Stillwater Dam. These two structures have reservoirs sufficient in size that the bedload material will be deposited in the reservoir and will not be sliuiced on down the stream. Diversion structures such as: Water Hollow, Layout, Vat, Hades, Rhodes, Win, and Docs will require sluicing in one form or another. Sluicing will consist of continual passage of the bedload during high runoff or may include only sluicing on an occasional basis for short periods of time. The exact method of sluicing will be determined through operations of the system. Sluicing will be restricted to the time of year when the streams are running high amounts of water. This will coincide with when the streams are naturally carrying high sediment loads and high amounts of bedload. Sluicing must occur at this time for two reasons. First, there will be sufficient water available to allow adequate movement of material to occur. Second, sufficient water is available to dilute the moving material thus preventing excessive erosion of the streambed immediately downstream of the diversion structure. Sluicing during the late summer, fall, and winter time, will not be carried out except in the case of an extreme emergency such as a very heavy local thunderstorm which could fill the diversion basin with material and which must be sluiced out in order to make the diversion operational.

Sluicing may occur as a continual action during the entire runoff season. To accomplish this the sluice gate would be opened a small amount and a continual flow of water which would carry the bedload from the diversion structure downstream, would be allowed to flow through the structure at all times. This sluicing action would be stopped when the stream above the diversion structure begins to clear up and no longer carries a heavy

sediment and bedload into the diversion structure basin. The second type of sluicing that will occur is to open the sluice gates on an intermittent basis during the runoff season. This may be as frequently as once per day but more likely will approximate once per week during the high flow period. The gates will be opened and the sluicing action allowed to take place until the diversion structure is cleaned of the trapped material. The gates will then be closed and the process stopped until the basin again fills with material. Once the streamflow above the diversion structure subsides and no longer carries large amounts of sediment or bedload this type of sluicing would be halted.

Sluicing of diversion structures in this manner whould allow full operations of the aqueduct with little or no damage to the structures, whicle at the same time causing minimum erosional degradation of the downstream channels.

## 2. GATES AND VALVES--EXERCISING AND TESTING

Safety of the structure and good operation and maintenance practices require that each gate (valve) be tested to confirm that it will operate as designed. Circumstances at each structure will govern the extent and frequency of testing.

CAUTION: If, during any test, the gate (valve) will not close from any position or otherwise malfunctions, stop the test and determine the cause of the malfunction and correct it. Contact the Utah Projects Office before further testing.

Exercising and testing machinery should be done by using normal and auxiliary power sources to ensure the operation of each. All exercising and testing results should be recorded and dated in the Operating Log at the dam.

Each gate or valve that releases reservoir water through an outlet works, including those designated as emergency gates and regulating gates or valves, shall be exercised through a complete opening and closing cycle annually under a balanced-head condition or with the outlet works unwatered. An operational test shall be performed on emergency gates once every 6 years. The test shall be developed for each specific emergency gate installation. At most facilities, raising the gates from 1 to 3 inches--from the closed position--with the downstream conduit unwatered will suffice.

> CAUTION: OPERATIONAL TESTING OF AN EMERGENCY GATE UNDER AN UNBALANCED HEAD SHOULD NOT BE PERFORMED UNLESS THE CONDUIT DOWNSTREAM FROM THE GATE IS EQUIPPED WITH EITHER AN AIR INTAKE VENT OR AN AIR INLET AND AIR RELEASE VALVE.

All required lubrication and maintenance of equipment should be done prior to operational testing and exercising.

## D. INSTRUMENTATION - MONITORING AND MAINTENANCE

Instrumentation, as it pertains to Upper Stillwater, Currant Creek, and Soldier Creek Dams, is covered in the separate SOP's for those facilities.

### 1. INCLINOMETERS

Inclinometers have been installed along the alignment of the Strawbery Aqueduct. Those needing to be read will be identified later.

### 2. HORIZONTAL DRAINS

Horizontal drains were installed beneath the pipeline invert to help stabilize the hillside by dewatering saturated material or to keep slopes from becoming saturated. Future conditions may warrant a monitoring schedule.

### 3. PIEZOMETERS

Piezometer and floatwell installations have been installed to measure water depths in the tunnels at a quiescent location. The information gained from a program of measurements can be used to evaluate the hydraulic roughness, to observe changes in the tunnel roughness over time, and to correlate flow depths with measured flows.

### 4. STRUCTURE MEASUREMENT POINTS

Structure measurement points have been installed at Water Hollow Diversion Dam. Elevations of the 33 settlement points, in reference to a brass cap bench mark, are used to detect settlement of the structure.

### 5. STRAIN GAGES

Monitoring cracks inside the tunnels may necessitate periodic measurements.

## E. MAINTENANCE AND INSPECTIONS

### 1. MAINTENANCE

Routine maintenance shall be performed on the Strawberry Aqueduct (trees and shrubbery should be cleared from fill material adjacent to concrete structures). Concrete repairs to the spillway and outlet works structures also will need to be done as required. Any unusual conditions which may adversely affect the safety of the structures should be reported promptly to the Utah Projects Office. That office will report to the Water Operations Branch in the regional office, and to the Chief, Division of Water and Land Technical Services, E&R Center. After consulting with other offices at the E&R Center, the chief will determine the type and number of additional reports required. If damage has occurred to the facility or appurtenances, the regional office will collaborate with the Utah Projects Office on interim measures pending further instructions from the E&R Center.

### 2. EMBANKMENT AND FOUNDATION INSPECTION

The embankment, abutments, and visible portions of the foundation adjacent to the main embankment shall be inspected for evidence of the development of unfavorable conditions. Inspect carefully for indications of:

| | |
|---|---|
| Cracks | Impairments of slope protection |
| Slides | Springs |
| Sloughs | Seeps |
| Subsidence | Boggy areas |

Following any reported earthquakes, an inspection shall be made of the facility embankment and appurtenances for indications of physical damage such as cracks, displacements, and land movements.

An inspection of the aqueduct will be performed annually by the Utah Projects Office, every two years by the Regional Division of Water and Land Operations, and periodically by the Engineering and Research Center. Deficiencies noted, together with recommended methods to correct them, will be given in writing to the Manager of the Central Utah Water Conservancy District. Reports of corrective action taken will be required of the District until the deficiencies have been satisfactorily absolved.

## F. SAFETY PROCEDURES DURING EQUIPMENT OPERATION

Safety procedures are important and must be diligently observed. The publications Construction Safety Standards and Power System Safety Standards will be available to all operating personnel. The appropriate standards established by these publications, particularly regarding rigging, ladders, cable, and equipment operation, will be adhered to at all times.

Safe clearance procedures shall be followed in the operation of the outlet works to safeguard personnel. When maintenance work or inspection is being performed on the electrical equipment, gates, or outlet works, all equipment that could affect personnel safety shall be appropriately locked or tagged to ensure that the controls are not handled while personnel are vulnerable to danger. A "Danger" tag used for such purposes reads "DANGER - HANDS OFF - DO NOT OPERATE." A danger tag is considered the same as a lock (a lock is preferred) and the tagged unit is not to be operated while the tag is in place. As an example, such a tag should be attached to control valves and gates by the operator when personnel are working on them. The operator alone should remove the tag after making certain that everyone is in the clear. Danger tags are supplied by the Utah Projects Office. Before each job is begun, the supervisor will conduct a thorough briefing so that all personnel involved will understand what is to be accomplished and the safety procedures to be used.

Except in the case of an emergency, repairs to electrical equipment, gates, or outlet works will be performed with two or more persons present. Even in an emergency, a second person will be informed of the work to be done and when a clearance report can be expected.2/

A record of the lockout and tagout shall be made in the facility's operating log to inform other personnel of the situation requiring these procedures. The manager or operator of the facility is to be responsible for posting and clearing the red-tag or lock equipment and area following the inspection. Under no conditions are conduits, tunnels, areas below gated spillways, etc., to be entered until the safety of the inspection personnel is ensured by lockout, tagout, and clearance procedures.

2/ Power O&M Bulletin No. 26, Power System Clearance Procedure, U.S. Dept. of the Interior, Bureau of Reclamation, rev., 32 p., Denver, Colorado, July 1982.


U. S. DEPARTMENT OF INTERIOR
BUREAU OF RECLAMATION
DANGER
HANDS
OFF
DO NOT
OPERATE
Signed by
Date
Time

## G. PROTECTIVE COATING - INSPECTION AND MAINTENANCE

The protective coatings on surfaces in various exposure conditions have been selected to provide either the lowest cost per square foot per year for corrosion control or both low cost and improved appearance over the life of the project. However, since most paints undergo gradual deterioration, achieving the expected results depends upon prompt and thorough maintenance to prolong their life. Specifically, scheduled inspections are required to assure recognition of the earliest signs of coating deterioration, and this must be followed by appropriate remedial measures. Delay in performing maintenance may permit the deterioration to progress to such an extent that complete replacement is required long before this would normally be expected. Further, because 100 percent effective inspection of all initial painting is not feasible, some areas receiving a deficient coating may show defects soon after the project goes into operation, and the first maintenance inspections are, therefore, of particular importance.

A discussion of common paint defects is included in the current edition of the Paint Manual under sections entitled "Maintenance Painting." The extent and type of maintenance repainting usually depend on characteristics of deterioration observed; i.e., blistering, disbonding, resting, pitting, etc., and the evaluation of such defects as they affect the choice of appropriate surface preparation procedures and replacement paints is detailed in the manual. Review of these "Maintenance Painting" sections is advisable prior to performing inspections, as well as afterward when repainting is planned.

When planning maintenance painting, selection of colors for use on surfaces exposed to public view should be coordinated with the projectwide program to maintain and improve the attractiveness of project facilities. Where a color schedule has been provided in the original construction contract documents, maintenance painting should conform to which conflicts with the color schedule provided in the original construction documents, or where it seems desirable to change the original color scheme, such changes should be resolved with the E&R Center prior to proceeding with maintenance painting. For facilities for which a color schedule was not provided in the construction contract documents, a coordinated color schedule for repainting should be developed consistent with a projectwide master color schedule designed to improve the appearance of all project facilities. The staff of the Assistant Commissioner - Engineering and Research includes professional personnel specially qualified in the development and coordination of color designs and provides services to assist the projects in this work. Requests for this professional assistance should be directed to the attention of D-261.

The value of coating inspection is also greatly enhanced if the past history of deterioration can be reviewed, particularly if major painting will be required and a change in the coating selection may be desirable. Judging the performance of a coating will, therefore, be greatly facilitated by keeping a permanent card file record for later reference. Commercial-punched filecards are the most convenient method, since coating type, location, exposure, age, condition, etc., can be coded for rapid hand sorting and analysis.

Many paints employed on Reclamation structures have somewhat unusual application characteristics requiring particular techniques to achieve satisfactory

results. Reference should be made to the Paint Manual, the manufacturers' instructions, or contact the Chief, Division of Research and Laboratory Services, Engineering and Research Center, for proper application procedures.

Listed below are several of the most important coatings employed by Reclamation, together with appropriate inspection schedules and comments as to maintenance procedures.

1. INSPECTION SCHEDULES AND MAINTENANCE MATERIALS

a. Coatings on metalwork in alternate or continuous water submergence. Paints in this category warrant the most rigorous inspection and energetic maintenance since corrosion failure may endanger metalwork in critical locations.

(1) Thin-film coatings:

VR-3, Vinyl resin paint
VR-6, Vinyl resin paint
Coal-tar epoxy paint, MIL-P-23236, Type 1, Class 2
Red lead, TT-P-86, Type IV, with or without topcoats of phenolic aluminum TT-V-119
Galvanizing

Coatings in this category should be inspected the first and third year after being placed in service, and thereafter at 3-year intervals. Maintenance paintings should be with the original type of paint. After 10 years of service, consideration should be given to application of one complete topcoat after preparing surface for repainting, as described in "Preparations for Repainting," Paint Manual. Repair of galvanizing may be by regalvanizing or, depending on circumstances, by application of protective coatings.

(2) Thick-film coatings:

(a) Coal-tar enamel should be inspected after the second and fifth year of service, and thereafter at 5-year intervals. Temporary repair of small areas should be made using coal-tar epoxy paint, and consideration should be given to making permanent repair to temporarily patched areas using coal-tar enamel after about 10 years of service.

(b) Cement mortar should be inspected after the first and fifth year of service, and thereafter at 5-year intervals. Repair may require special methods, possibly including use of epoxy bonding materials.

b. Coatings on wood, masonry, or metalwork in other exposures. Although deterioration of these coatings will usually progress more slowly and the consequences of failure will be less serious, significant economies will be affected by proper maintenance. After a third-year inspection, subsequent inspections of paints in exterior or interior exposures may be scheduled at 2- to 5-year intervals, depending on the apparent need.

c. Coatings on surfaces which are normally inaccessible or only occasionally exposed. It is not intended that equipment be dismantled simply for inspection purposes, or that unreasonable expenses be incurred through otherwise unnecessary shutdowns to examine coatings. However, when opportunity arises for inspection of surfaces which are seldom exposed, a detailed report of the coating conditions observed should be prepared for later reference and maintenance work scheduled, if required.

d. Miscellaneous materials. Canal groove sealers, concrete epoxy repairs, dampproofers, roofing, and similar materials are susceptible to gradual deterioration comparable to that sustained by coatings. They require regular maintenance and should be included in the inspection schedule; a 3-year interval will usually be suitable.

# CHAPTER III

# AQUEDUCT OPERATIONS

## A. DESIGN FLOOD STUDY AND ROUTING

The inflow design flood for Upper Stillwater, Currant Creek, and Soldier Creek Dams and Reservoirs were prepared in the Denver office and can be found in the respective SOP's.

The inflow design flood for the following diversion structures has no relevance;

Docs Diversion Dam
Win Diversion Structure
Rhodes Diversion Dam
Layout Creek Diversion Structure

Vat Diversion Dam has been designed to maintain a minimum freeboard of 4.0 feet above the 50-year flood water surface and a minimum freeboard of 3.0 feet above a 100-year floodwater surface. The 50-foot-wide ogee-type spillway is designed to pass a 50-year floodflow of 1,500 $ft^3/s$ at a reservoir water surface elevation of 7,814.9. The crest elevation is 7,811.00 which is 0.5 foot higher than the reservoir water surface required to divert 300 $ft^3/s$ into the headworks. A radial gate, 10-by 18-foot, controls the 10-foot-wide sluiceway. When the gate is closed, it will have 1 foot of freeboard above the 50-year floodwater surface. The top of the operating deck (elevation 7,816.00) was set a minimum of 1 foot above the water surface for a 50-year flood.

## B. FILLING SCHEDULE AND RELEASE PROCEDURES

Filling procedure for Strawberry Aqueduct, Upper Stillwater Flow Control Structure to Currant Reservoir.

The following filling procedure assumes North Fork Siphon, Wolf Creek Siphon, West Fork Pipeline, and Vat Feeder Pipeline are filled (pooled). Existing flows, zero to design from Hades, Win, Rhodes, and Vat Diversions will cause only minimal changes in flow depth and velocity and will benefically reduce the travel time for each of the valve openings below.

UPPER STILLWATER FLOW CONTROL STRUCTURE FILLING SCHEDULE

| Time (Hours) | Flow Increase ($ft^3/s$) |
|---|---|
| 0.0 | 0-15 |
| 2.0 | 15-50 |
| 4.5 | 50-100 |
| 6.0 | 100-160 |
| 7.0 | 160-225 |
| 8.0 | 225-285 |

This filling schedule limits bore wave heights to 8 inches for sudden flow increase. Velocity of the bore wave varies from 9 to 20 ft/s as the successive stages have increasing depths.

Since the bore wave velocity is two to three times the subsequent uniform velocity in these open flow reaches, with aggregate length of 108,600 feet, a much subdued bore wave will arrive at Currant Reservoir several hours ahead of its respective uniform flow. Also, since both bore waves and their increments of uniform flow travel faster in deeper water, successive bore waves can overtake the preceding bore waves if the flow increases have not been adequately spaced. The combined mass with increased velocity will more than double the momentum, although with these small bore waves the result is acceptable.

Thus, an uncontrolled, sudden addition of flow from both Hades, Win, and Rhodes diversions can be absorbed as a nominal to unusual occurrence. Note these are stream run and can actually divert 36 $ft^3/s$ and 40 $ft^3/s$, respectively.

The potential for large and sudden discharges from the Vat diversion (full open in 60 seconds), indicates the need for a valve opening schedule similar to that recommended for Upper Stillwater flow control Structure. the increment of flow increase remains the same but the shorter travel times allow shorter delays. Since both tables are conservatively based on uniform flow velocities rather than bore wave velocities, the Vat Diversion schedule can be added to any preexisting flow up to the design maximum of 475 $ft^3/s$ for Vat Tunnel. If both Vat Diversion and Upper Stillwater Flow Control Structures are to be opened, the Vat flow should be stabilized 1 hour before Upper Stillwater releases begin.

VAT DIVERSION FILLING SCHEDULE

| Time (Minutes) | Flow Increase ($ft^3/s$) |
|---|---|
| 0 | 0-15 |
| 55 | 15-50 |
| 80 | 50-100 |
| 95 | 100-160 |
| 105 | 160-225 |
| 115 | 225-300 |

If one or more of the closed conduits is empty at the beginning of the filling, add the interval(s) shown below to the 15 $ft^3/s$ initial rate before increasing the flow rate to 50 $ft^3/s$.

| | |
|---|---|
| North Fork Siphon | 2.5 hours |
| Wolf Creek Siphon | 10.0 minutes |
| West Fork Pipeline | 13.6 hours |
| Vat Feeder | Ignore |

The following filling procedure assumes that the Currant Creek Pipeline, Layout Creek Siphon, and Water Hollow Creek Siphon is each filled. Any flow from the Layout Creek and Water Hollow Diversions will beneficially reduce the travel time for each of the gate openings below.

CURRANT CREEK PIPELINE GATE STRUCTURE - FILLING SCHEDULE

| Accumulated Time (Hours) | Flow Increase ($ft^{32}/s$) |
|---|---|
| 0.0 | 0-50 |
| 1.3 | 50-200 |
| 2.0 | 200-400 |
| 2.5 | 500-580 to 620 |

The larger base flow relative to the diversions, common large diameters and slopes, and shorter combined length of 48,070 feet for the lower reach of the aqueduct, each contribute to a simpler and faster filling schedule than that for the upper reach. The bore wave comments apply uniformly.

If one or more of the closed conduits is empty at the beginning of the filling, add the respective rates for the intervals shown below before increasing the flow rate to the next appropriate increment.

| | |
|---|---|
| Currant Creek Pipeline | 40 (not 50) $ft^3/s$ for 2.4 hours |
| Layout Siphon | 40 $ft^3/s$ for 0.7 hours |
| Water Hollow Siphon | 40 $ft^3/s$ for 2.0 hours |

The principal function of Upper Stillwater Dam is to divert a flow of water up to 285 $ft^3/s$ into the Strawberry Aqueduct. In addition, the river outlet works will provide discharges up to 29 $ft^3/s$ to maintain minimum streamflows in Rock Creek for fishery and downstream users needs.

Docs Diversion Dam is designed to divert up to 100 $ft^3/s$ of water into the feeder pipeline. Flows in excess of those required for diversion will pass over the inlet grating of the unregulated structure.

Hades Feeder Pipeline has a design flow of 30 $ft^3/s$, however, the diversion flow from the Hades Creek Diversion Dam is controlled by the pressure head. Hades Creek Diversion Dam is an unregulated structure that diverts up to 30 $ft^3/s$ of water. A minimum downstream flow requirement of 1.5 $ft^3/s$ is bypassed while remaining flows, up to 36 $ft^3/s$, will be diverted.

The North Fork Siphon is designed for 305 $ft^3/s$ in its downstream half, and 285 $ft^3/s$ in the upstream half. A tee intersection incorporated in the blowoff structure at the bottom of the canyon, provides for 30 $ft^3/s$ of flow into the aqueduct from the Hades Feeder Pipeline.

The Win Diversion Structure will divert Twin Creek flows up to 5 $ft^3/s$ into the Win Feeder Pipeline. The remaining flow will pass over a streambed grating.

Rhodes Diversion Dam will divert up to 30 $ft^3/s$ of water from Wolf Creek into the Rhodes Feeder Pipeline.

Wolf Creek Pipeline is 7 feet in diameter with a carrying capacity of 325 $ft^3/s$.

Vat Diversion Dam on the West Fork of the Duchesne River is designed to maintain a regulating reservoir of 40 acre-feet and is capable of diverting up to 300 $ft^3/s$ of water to the Strawberry Aqueduct and up to 30 $ft^3/s$ as a fishery bypass.

Vat Tunnel flow will be the individual flow either through West Fork Pipeline or from the Vat Diversion, or a combination thereof not to exceed 475 $ft^3/s$. Releases from Upper Stillwater Dam are to be operated so that the Vat Diversion will divert close to maximum flow.

The Currant Creek Dam headworks is designed to provide a discharge capacity of 620 $ft^3/s$ to Currant Creek Pipeline. The full 620 $ft^3/s$ diversion is permitted only when water is not being diverted into the system by either the Layout Creek or the Water Hollow Diversions. The outlet works and the diversions must be operated so that the design capacity of 620 $ft^3/s$ is not exceeded for any one of the features. Currant Creek Reservoir may fluctuate between elevations 7,674.0 and 7,678.0. The reservoir should be filled and remain full for the recreation year. Drawdown to the inactive storage level could take place in October for winter operation.

Layout Creek Diversion is a reinforced concrete drop inlet structure that will divert up to 20 $ft^3/s$. Flows in excess of those required for diversion and sluicing will pass over the grating located at the streambed elevation.

Water Hollow Diversion Dam has a 25-foot-wide spillway crest at elevation 7,644.0, which is approximately 6 inches higher than the reservoir water surface elevation required to divert 20 $ft^3/s$ into the headworks. Any time that the flow of Water Hollow Creek is greater than 20 $ft^3/s$, the maximum divertable flow, the reservoir will fill. When the elevation reaches 7,644.0 the uncontrolable spillway will bypass the excess. A gauging station below the diversion structure measures and records all streamflows that pass the dam.

## C. INFLOW FORECASTING

Forecasts of inflow into the Strawberry Aqueduct drainages are made jointly by the Weather Bureau and the Soil Conservation Service. The forecasts are published as of the first of each month from January to May for water year flows and for remaining flows through September.

## D. LANDSLIDE SURVEILLANCE

There are minor landslide areas in the vicinity of the Strawberry Aqueduct but none which require the establishment of special instructions for O&M personnel. The Central Utah Water Conservancy District has a continuing responsibility to report immediately to the Utah Projects Office who will report to the Regional Supervisor of Water and Land Operations and to the Regional Geologist, all unusual land movements observed during project operations.

## E. PREVENTING OIL POLLUTION OF WATER

There are no existing oil pipelines which could affect the watershed contributing to Strawberry Aqueduct. However, it is the responsibility of the operating personnel to remain alert to and cognizant of possible future developments of any pipeline or other source of petroleum or chemical pollutant which might enter the streamflow or otherwise affect the quality of water. Any such development should be reported to the Utah Projects Office.

## F. FISH AND WILDLIFE CONSIDERATIONS

The Utah State Wildlife Resources Division is responsible for all fish and wildlife activities in the State and, therefore, is responsible for regulations regarding fishing and gaming laws and the enforcement thereof. That agency is also responsible for providing good fishery conditions through fish stocking programs and the development of good fish habitat.

Minimum fishery releases from some structures have been set (see chart below). The Bureau of Reclamation reserves the right to vary the reservoir water levels in accordance with all necessary project operations. The minimum releases shown in the table are guaranteed until the year 2000. At that time new releases will be negotiated.

Table of Minimum Fishery Releases. Taken From Working Agreement Among Stream Flow Agreement Committee Members - September 1986

CUWCD and Reclamation have agreed to operate the Strawberry Collection System during the period from 1986 through 2000 so that bypasses will be provided at appropriate features to maintain the following flows as minimums or the natural inflow whichever is less[1/]:

| | Stream | | | |
|---|---|---|---|---|
| Month | Rock Creek | West Fork[2/] | Currant Creek | Strawberry River |
| Oct | 23 | 9.5 | 9 | 13 |
| Nov | 23 | 8.0 | 9 | 13 |
| Dec | 23 | 6.5 | 9 | 13 |
| Jan | 23 | 6.5 | 9 | 13 |
| Feb | 23 | 7.0 | 9 | 13 |
| Mar | 23 | 6.5 | 9 | 13 |
| Apr | 29 | 24.0 | 24 | 26 |
| May | 29 | 24.0 | 24 | 26 |
| Jun | 29 | 24.0 | 24 | 26 |
| Jul | 29 | 24.0 | 24 | 26 |
| Aug | 29 | 15.0 | 23 | 26 |
| Sep | 29 | 12.0 | 23 | 26 |

1/ The committee will meet annually to determine exact releases. Thus, this table may occasionally be revised for a particular year. However, the total amount of the fishery diversions will always approximate 44,400 acre-feet.

2/ August-March vary because they approximate the mean run of the river flows. It is recognized that these flows may not be available on a daily basis.

## G. DOWNSTREAM IRRIGATION REQUIREMENTS

In determining irrigation requirements, the amount of water needed to satisfy the evapotranspiration of the crops, from all sources, must be considered. It includes the amount of water used by the crops from all sources whether it be water from precipitation, applied by irrigation, or from ground water.

An annual irrigation diversion requirement of 4.0 acre-feet per acre was adopted for all serviceable lands along Duchesne River tributaries. After the net effects of precipitation and ground water, direct streamflow available at heads of canal, which may vary from year to year and season to season, are then utilized to meet the irrigation requirements. The bypass requirement for irrigation at Strawberry Aqueduct diversion points is dependent on the measurements taken at gauging stations downstream of the aqueduct. Bypass for fishery habitat and spills at aqueduct diversion points can also be utilized to meet irrigation demands. The downstream irrigation requirement is also dependent on decreed water right acreages served from the Duchesne River which were identified by the Duchesne River Area Study Committee.

The irrigation bypasses from Hades Diversion, Win Diversion, and Rhodes Diversion are dependent on the flow of Duchesne River near Hanna, Utah (U.S.G.S. Gauge No. 2770), and the water right acreage above the Tabiona gauge of 5,987 acres. The monthly distribution of the irrigation requirements is as follows:

| | APR | MAY | JUN | JUL | AUG | SEP | OCT | TOTAL |
|---|---|---|---|---|---|---|---|---|
| Percent | 0 | 6 | 23 | 30 | 22 | 17 | 2 | 100 |
| Acre-feet | 0 | 1,437 | 5,508 | 7,184 | 5,269 | 4,071 | 479 | 23,948 |
| $ft^3/s$ | 0 | 23 | 93 | 121 | 86 | 68 | 8 | |

The irrigation bypasses from Upper Stillwater Dam and Docs Diversion are dependent on the flows of Duchesne River near Tabiona (U.S.G.S. Gauge No. 2275) and the flows of Rock Creek near Talmage (U.S.G.S. Guage No. 2791) and the water right acreage between Tabiona and Duchesne of 7,034 acres. The monthly distribution is as follows:

| | APR | MAY | JUN | JUL | AUG | SEP | OCT | TOTAL |
|---|---|---|---|---|---|---|---|---|
| Percent | 1 | 14 | 23 | 25 | 21 | 14 | 2 | 100 |
| Acre-feet | 281 | 3,939 | 6,471 | 7,034 | 5,909 | 3,939 | 563 | 28,136 |
| $ft^3/s$ | 5 | 64 | 109 | 114 | 96 | 66 | 9 | |

Under Bonneville Unit conditions, the diversion requirements of the service area below Duchesne are supplied by return flows from irrigation service above Duchesne, future modified flows of the Duchesne and Strawberry Rivers, and releases from Starvation Reservoir for replacement of nonsurplus water diverted to the Strawberry Aqueduct and for project supplemental irrigation demands.

The Duchesne River Commissioner is responsible for the distribution of the water supply of the Duchesne River according to decreed water right priorities. Water rights of existing water users are senior to water rights of Bonneville Unit. Under Bonneville Unit operation, the existing rights on

Duchesne river and its tributaries will be supplied by direct flow diversions in accordance with water right priorities, except where modified by exchange agreements. Flows in excess of these rights are considered available for storage in Starvation Reservoir or for diversion through the Strawberry Aqueduct. Bypasses at aqueduct diversion points will be adjusted as directed by the Duchesne River Commissioner to ensure that downstream demands are satisfied according to decreed water right priorities.

## H. OFF-ROAD VEHICLE REGULATIONS

The U.S. Forest Service has primary jurisdiction in the area and is responsbile for restrictive posting.

# APPENDIX A

## Drawings

### Bureau Drawings

The latest revised prints of all Bureau drawings mentioned in the text have been included in the Designers' Operating Criteria.

| No. | Drawing No. | Title |
|---|---|---|
| 1 | 66-D-376 | Currant Tunnel |
| 2 | 66-D-610 | Layout Creek Stream Inlet |
| 3 | 66-D-611 | Strawberry Aqueduct |
| 4 | 66-D-612 | Stilling Well and Sections |
| 5 | 66-D-2281 | North Fork Siphon |